THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 28. Thursday, July 12th, 1923. No. 360.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
The Price of Light Castings	23
Cleaning Castings	23
National Light Castings Association and the Prices of Building Materials	24
"Moulders" of the Industry—No. 8	24
Report on Sand Reclamation Investigation of the American Steel Foundries	25
Catalogues Received	28
Necol Plastic Wood	28
An Apprenticeship Course in Foundry Practice—XLIX.	29
Jointing Materials for Silica Refractories	31
Canadian Pig-Iron and Steel Production in May	31
Refining Reactions in Basic Electric Steel Furnace Practice	32
A Simple Moulding Machine	33
Centrifugal Pipe Casting	33
The Manufacture of Steel Castings in the United States	34
A Novel Method of Scrap Sorting	38
Graphite in Grey Iron	39
Iron and Steel Markets	40
Personal	41
Company News	41
Gazette	41
Trade Talk	42
Obituary	42
Cold Bend Test on Iron and Steel Bars	42

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.
PRESIDENT, 1923-24, Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.
LIST OF SECRETARIES—
General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.
Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.
London: V. C. Faulkner, 21, Stanley Gardens, W.11.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, 37, Melville Road.
West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.
Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

The Price of Light Castings.

We gather that the main point in the Interim Report of the Inter-departmental Committee appointed by the Minister of Health to survey the prices of building materials in so far as it affects the foundry is that since the price of No. 3 Cleveland pig-iron has fallen from 127s. 6d. to 115s. per ton according to the Report, or actually to 111s. 6d. per ton, then the price of light castings should be reduced accordingly. The most pertinent question is obviously one relative to the stability of the pig-iron market. Whilst pig-iron production is now higher than for a long period, there is a tendency for the furnaces to shut down as they become no longer economic units below a certain pig-iron selling-price. Again, there is a certain overlapping in periods and prices; for instance, some fortunate foundries were using irons in May, bought last autumn. This factor makes difficult any quick price-regulation of light castings when based on the pig-iron market, especially when controlled by such an influential consortium as the National Light Castings Association. If individual action were nationally operative, then those foundries, which had covered themselves for future deliveries on a 92s. per ton market, would be able to pass this price on to the builders' merchants, which would tend to put those less favourably placed out of business, at least temporarily. When the pig-iron stocks had been consumed, then prices of light castings would reach perhaps a higher level than now, because not only would those foundries, which had bought favourably, but also all the others, because they too would now compete for high-priced pig-iron. Therein lies the value of the National Light Castings Association; its disadvantages are those associated with the inherent power of monopolists. The Association, which has been in the lime-light a good deal since its inception, can, potentially, do more for the cheapening of house construction than any effort made by an individual firm. It is to be hoped that for the good name of the foundry trade they will put forward a real national effort for the cheapening of light castings by modern engineering methods and to resist the temptation of maintaining high prices by the limiting of production, or other means.

Cleaning Castings.

Last week we published in full the proposed Home Office Regulations for the cleaning of castings. The object in view was to give foundrymen, not only an opportunity of studying them, but of applying them to their practice wherever possible, because obviously if every foundry in Great Britain did so, the necessity of enforcing the Regulations would not exist. We hear on reliable authority, however, that in one important district the existing regulations for grinding are scarcely being met, so that it cannot be wondered at if the proposed regulations will be ignored until they become law.

We fail to see in the regulations anything of such a character, that it is beyond the economic capacity of most foundries, and the adoption would in the long run *be an economic asset, because increased production invariably follows hygienic working conditions.*

The more enlightened foundry owners will no doubt take immediate steps to make their fettling shops conform to the proposed regulations, and we would most strongly advise them to get into touch with Mr. E. L. Macklin, H.M. Engineering Inspector of Factories, at the Home Office, Whitehall, by sending to him drawings and descriptions of what they intend to do, for, by doing this, not only will they have the satisfaction of knowing that they have done everything necessary to make their shops strictly hygienic, but also they will have the benefit of having the *free advice of specialised engineers who have visited the whole of the foundries of Great Britain*, and who are familiar with the best and cheapest methods of accomplishing the desirable object of increasing the health and obviously the efficiency of the foundry worker.

There is one difficult factor associated with this problem, that is, many foundry designers, having in mind the laudable object of minimising transport, keep the whole of the foundry operations, except machining, under one roof, and make near

the dispatch end of shop the fettling department. From a careful study of the Report, it will be gathered, that it is better, whenever possible, to have a separate shop for this work, and further, one can visualise that in the distant future, it will be proposed that all fettling shops are to be provided with a grate-floor, with suitable exhaust and conveyor arrangements for removing the burnt sand and dust. Of course, exceptions will still have to be made for large castings, such as turbine casings, as they are far too heavy and bulky and too few in number to warrant their removal to a shop where dust removal apparatus was provided. Size alone would render this both a sanitary-engineering and economic impossibility.

The Clause (8) dealing with the cleaning of fettling shops every three months, does not imply whitewashing, which is governed by general Factory Regulations, and will involve much work in the untidy factory, but the very fact that a foreman knows he has to "spring clean" quarterly will tend to make him keep the shop tidier, and will prevent those untidy heaps of castings and tackle, which are a disgrace to many of the smaller foundries.

Tumbling barrels, from the medical aspect, appear to be bad pulmonary disease originators, and designers and sellers of this type of plant would be well advised to bring their machines up-to-date by making provision for exhaust arrangements or by running with the lower half in steam-heated water.

National Light Castings Association and the Prices of Building Materials.

The Inter-Departmental Committee of the Ministry of Health appointed to survey the prices of building material, report with respect to light castings that, almost concurrently with their appointment, the National Light Castings Association, which controls the prices of the bulk of the light castings produced in this country, announced an increase of 10 per cent. in the prices of certain goods used in housebuilding. The Committee at once took steps to investigate this matter, and, after preliminary inquiries, appointed a Sub-Committee to visit Scotland, which is the chief centre of the light castings industry in this country. A long interview with representatives of the Association took place in Glasgow, at which it was stated that after careful consideration extending over several months, and after negotiation with the Committee of the distributing merchants, a new and reduced scale of prices had been settled, which took effect on February 1 of this year. The Committee reserve their judgment as to the basis of this February scale, and express no opinion in regard to it, because they are still waiting for certain information which has been promised to them, and more detailed investigation may be necessary. But there is one observation which the Committee think they may usefully make at once. It so happened that almost simultaneously with the announcement of the February prices, the cost of pig-iron, the raw material of light castings, began to rise. In January, the price of No. 3 Cleveland was 92s. per ton, in February 105s., and in April, when the peak was reached, it was 127s. 6d. Then, on May 1, the Association made an increase of 10 per cent. on the February prices of certain lines of goods. It was, of course, noted at the time that these were the very goods used in building small houses, but the Committee put on record the statement made to them by the Association that this had nothing to do with the announcement in March that the Government were about to give further subsidies for the erection of such houses. The Committee think that it is also their duty to record the fact that the representatives of the Association agreed with them in Glasgow that when the effect of the Ruhr occupation on prices passed away, the recent increase ought to be reconsidered. The output of pig-iron in this country has been greatly augmented in the last few weeks and the price of No. 3 Cleveland has already fallen to 115s. a ton. Except in the case of coke, which is not a comparatively large item in the production of light castings, they are not aware that any of the other costs either of manufacture or distribution have increased since February, wages have been stationary, and railway rates and national and local taxation have tended downwards. It seems to the Committee, therefore, that by their own showing a reconsideration by the Association of the May increase is almost due.

"Moulders" of the Industry.—No. 8.

Mr. F. J. Cook.

Mr. F. J. Cook, who is a Past-President of the Institute of British Foundrymen, was born at Coseley, in Staffordshire, in 1870.

His technical education was gained at the Wolverhampton Technical School, where he was the Queen's Prize winner in 1890. His apprenticeship

MR. F. J. COOK.

was served with Messrs. Joseph Evans & Sons, of Culwell Foundry, Heath Town, Wolverhampton, where he spent much of his time in the pattern shop and foundry. On coming of age he associated himself with Messrs. George Belliss, afterwards Bellis & Morcom, Limited, where he spent much of his time in the drawing office until 1898, when he was appointed foundry and pattern-shop manager. He made his first change in 1916, when he joined the board of directors of Messrs. Rudge Littley, Limited, of Swan Village, West Bromwich, a position he still holds. This company do every class of foundry work, including grey iron, malleable, and non-ferrous.

Mr. Cook was practically a founder of the Institute of British Foundrymen, and occupied the chair from 1908 to 1910. He is this year the President of the South Staffordshire Iron and Steel Institute. Amongst other offices he has held is that of vice-president of the Birmingham Metallurgical Society. He is vice-chairman of the British Cast Iron Research Association, and presides over its Research Committee. Finally he is Chairman of Panel 2, Sub-Committee 7, of the British Engineering Standards Association.

On his return from a visit to the States last year, he was awarded the Oliver Stubbs' Gold Medal, for his researches into foundry problems, and particularly for a Paper he presented to the American Foundrymen's Association.

Amongst the more prominent of the numerous Papers he has read is that which he gave in 1910, in collaboration with the late Mr. George Hailstone, on the Structure of High Strength Cast Iron, in which the characteristic network structures of cementite and phosphide eutectic were first noted.

Report on Sand Reclamation Investigation of the American Steel Foundries.*

Because of the scarcity of steel moulding sand of the best quality and the problem arising from having to dispose of large amounts of refuse sand, this company has carried out an intensive investigation of methods of reclaiming the good material which is usually lost when the so-called refuse sand is thrown away.

After experimenting along many different lines and thoroughly going over methods employed in other plants, a process of reclaiming old sand called "centrifugal scrubbing" has been developed. After establishing the principle of this method, J. C. Davis designed and the American Steel Foundries took out patents covering equipment which permits the economical reclamation of old steel sand. Particular attention is called to analysis of refuse sand which was used as a basis for the final solution of the problem.

Theory of Sand Reclaiming.

Closely associated with the theory of sand reclaiming are the reasons why refuse sand is no longer fit for further use, for refuse sand is a cosmopolitan product for it contains both good and bad material.

Bad Material.

A-1. Small free particles of fused fireclay, flour or other bonding material which has been rendered useless. Also an excess of this material when in good condition.

A-2. Small grains of sand which are covered by reduced bonding material, either fused or attached to surface of grains.

A-3. Large grains of sand which are covered by reduced bonding material, either fused or attached to the surface of the grains.

A-4. Combinations of large or small grains or both, fused together and covered with reduced bond material.

A-5. Foreign objects, such as scrap balls, chills, gaggers, spills, scale and others of similar nature.

A-6. Some fine particles of other material which has become fused or reduced or which is of such character that it will not bond, take high temperature or which is for other reasons unsatisfactory and therefore undesirable.

Good Material.

B-1. Small free grains of good fireclays, flour or other bonding material.

B-2. Small grains of sand either clean or covered with good bonding material.

B-3. Large grains of sand, either clean or covered with good bonding material.

B-4. Combinations of large and small clean grains of sand or both held together only by the adhesive power of good bonding material.

A-1. In the above reclaiming process it is necessary to entirely separate and remove all A-1 particles because of its objectionable nature, reducing bond, reducing fusion point of sand, and filling up voids.

A-2. This item covers the small grains of sand which were originally included under B-2, but have been heated to a point to make the sand grains plastic and decomposed the bonding material has become attached. This material left in the sand means increased bonding material. This item is the most important one to be considered in sand reclaiming and no process will be satisfactory unless it is efficient in this regard. If it were feasible or in any way possible, the removal of A-2 material would simplify the process, but up to the present no method has been discovered which will separate A-2 from its companion B-2. If such a plain separation were developed which at present appears impossible, there would still exist an important barrier which would preclude adoption in practice. By far the greatest proportion of refuse sand is that included in A-2 and A-3. If all A-2 and A-3 material were removed in a reclaiming process by plain separation, the resultant yield in good material would be so reduced that the process would probably not be an economical one.

A-3. The condition of A-3 material is such that it is also necessary to subject it to a preparation process to break it down and remove the strongly attached objectionable matter, reducing it to A-1 and A-3, and as such it is easily susceptible to plain separation methods.

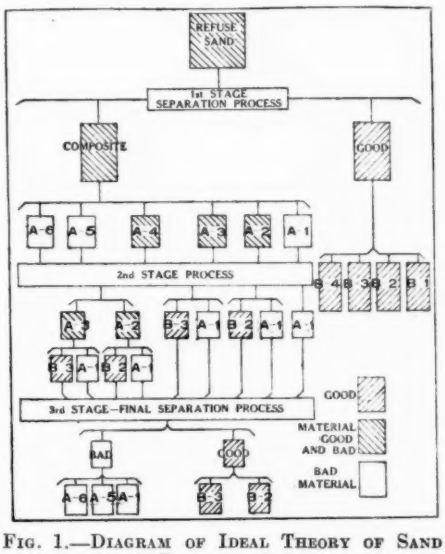


FIG. 1.—DIAGRAM OF IDEAL THEORY OF SAND RECLAMATION.

A-4. This item includes combinations of A-2 and A-3 and is a companion to B-4 except that the combination is supported by fusion instead of legitimate bonding action. To be handled with success it must first be broken down into A-2 and A-3 which in turn must be put through a preparation process to further separate them into A-1 and B-2 or A-1 and B-3. The A-4 combination is objectionable for the same reason as A-2 and also because

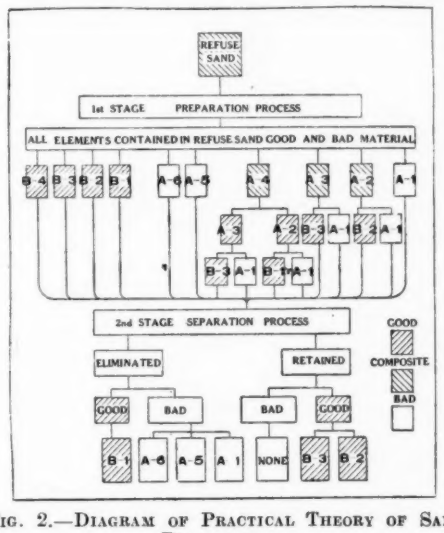


FIG. 2.—DIAGRAM OF PRACTICAL THEORY OF SAND RECLAMATION.

a combination of grains assumes a very irregular shape and if the combination is allowed to continue growing, it would become joined with similar combinations. The principal objection, however, is the fact that irregular shapes provide a harbour for the lodgement of A-1 material and in addition to its irregularity presents a difficult matter for proper bonding, making it imperative to use a larger amount of bonding material with a consequent deleterious effect.

* A Report presented to the American Foundrymen's Association. Major R. A. Bull referred to this in the I.B.F. Exchange Paper.

A-5. This item includes all foreign materials which are in no form related to the original material. Its separation from the sand is a simple matter.

A-6. This item covers all material included in the division of bad material not included in any one of the preceding " A " items. There are certain minute impurities in new sand which are rendered entirely objectionable after being subjected to comparatively low temperatures, and these should be removed in any process of reclamation.

Owing to cleavage plans, partially existent in some of the small new sand grains, and the expansion and contraction caused by the heat of casting, grains break sometimes into small parts and again in some cases small particles are spalled off the edges of the larger grains.

Again there are minute particles of iron oxide or slag which must be removed. Owing to the fact that all A-6 material is very minute in size and cannot build up to form larger combinations, it is not difficult to eliminate. Any process that will effectively remove A-1 material will likewise remove A-6 material.

B-1. Under this item is included all the small free particles of good fireclay, flour, or other bonding material.

B-2. Under this item is included the small or fine grains of sand which have not been subjected to a high temperature.

B-3. Is identical with B-2 except for size.

B.4. This item covers combinations of materials which have been described singly under B-1, 2 and 3. This combination breaks down in mixing, milling, or even by ramming.

It will be evident that the items listed both under the good and bad material are the simple forms which are encountered. It will also be evident that some material would literally be included in both the good and the bad material under the corresponding item, due to the fact that it is not wholly in one condition. It is necessary, as indicated in the ideal theory of sand reclaiming (as later described), to resort to some scheme of preparation as an important part of any successful process of sand reclaiming. The advantage of preparation to A-2 material is the fact that the yield of reclaimed product is materially increased by breaking up the A-2 material into its constituent elements, A-1 and B-2. When this division of A-2 has been made, the situation assumes a simpler aspect and it is not at all difficult to institute now an additional process of separation which will retain the renovated grains of sand B-2 and discard the fine particles A-1. Before leaving the subject of this item, it is necessary to make some remarks on the preparatory stage of the process. The decomposed bond A-1 is attached to small and large sand grains A-2 and A-3 in a very substantial and permanent manner, and a process to remove it must be thorough, somewhat severe and even perhaps violent in order to remove the objectionable matter from the surface of the sand grains.

Refuse sand has been described as being divided into two broad divisions. From Fig. 1 an inference could be drawn that sand reclaiming should consist essentially of separating the good from the bad material. Early investigators were misled in the belief that a solution of the problem consisted solely in a simple separation process, and they devoted their energies to perfecting apparatus to accomplish this purpose, but their fatal mistake was the simple fact that they failed to distinguish in their separation methods between the actual good and the actual bad material.

It can be clearly seen now why these efforts were not successful and why the progress made was very slow. In addition to misconception in theory, the early efforts were all directed to develop a one-stage continuous apparatus, so that refuse sand would continuously enter and reclaimed material be continuously ejected.

The theory of ideal sand-reclaiming may be described as a composite process. The proper thing to do first would be to separate the actual good from the so-called bad material. To stop at this point would not be permissible, for the reason that there is a considerable portion of the so-called bad material which has possibilities of rehabilitation. The next step, then, develops into a process of preparation wherein this material is worked over, and from here leads to a still further stage of final separation to remove the re-established good material. The results of the ideal system would be that every item of good material would be retained, and every item of bad material rejected. To accomplish the ideal reclamation it would be necessary to develop apparatus that would separate two items that are exactly similar in every way except their physical condition.

Practical Theory of Sand Reclaiming.

It is not at present possible to obtain an efficiency of 100 per cent. in sand reclamation, but the following explained theory shows a reclamation process which is practical and which can be accomplished with the present stage of the art. The practical theory is different from the ideal theory in that some of the good material is lost with the waste product. In the practical theory the refuse sand is first put through a process of treatment which thoroughly cleans each grain of sand, either large or small. When the cleansing action has been completed or during the time it is in process, all material removed from the sand grains is separated from the sand grains and carried away as a waste product. The preparation or cleansing part of the process would be nothing more than scrubbing each individual grain of sand until each grain was perfectly clear of any adhering matter.

In this process some good matter in the form of effective bonding material is removed with the bad material.

In the practical theory, the preparation of the sand or cleaning stage of the process is one which would have to be superinduced by some mechanical action, while the separation part of the process could be secured by flotation methods, using either air or water as a means of obtaining the desired results. The practical methods require that each grain be cleansed of both good and bad material.

Any practical system of reclaiming must be measured according to the degree of cleanliness imparted to the sand grains and the thoroughness of the separation of the process.

Experiments of American Steel Foundries to Determine most Effective and most Economical Means of Reclaiming Sand.

Tests were run on sand for grain shape and size, and condition under the following seven conditions :—

		Average	Screen Size.
1.	Refuse Sand	Fineness	39.57
2.	Plain air separation	Fineness	27.45
3.	Centrifugal air scrubbing ..	Fineness	25.69
4.	Plain water separation	Fineness	35.92
5.	Water scrubbed	Fineness	33.46
6.	Both water and air scrubbed	Fineness	27.26
7.	New Moulding sand	Fineness	34.50

Comparison of Fineness of Sand Reclaimed by Various Methods.

	Retained on mesh.					
Mesh Size.	20	40	60	80	100	Thro'.
No. 1. Refuse Sand	1.2	39.4	37.3	11.4	4.4	6.3
No. 2. Air separated ..	2.1	65.9	27.4	3.9	0.9	0.1
No. 3. Air scrubbed	1.1	72.9	23.4	2.2	0.4	0.0
No. 4. Water separated ..	0.8	39.9	41.4	11.6	5.3	1.0
No. 5. Water scrubbed ..	2.0	45.0	33.9	8.9	3.0	0.4
No. 6. Water and air scrubbed		69.0	26.5	3.4	.8	.2
No. 7. New sand		50.0	35..	9.1	4.0	1.8

The air-scrubbed and air-separated method proved most practical and economical a solution of the problem, for it was found that about 70 per cent. of the refuse sand could be reclaimed. Plain air or water separation did not put the grains of sand into good condition, a violent scrubbing action being found necessary to remove the fused material coating the sand grains. After the best method was determined attention was given to the development of equipment which would perform the work most satisfactorily and economically.

Reclaimer for Dry Refuse Sand.

Previous to the development of this device, various attempts had been made to reclaim moulding sand by separation and by means of air or water flotation, but these methods were only partially successful. In the air or water separation methods no decided change was wrought in the physical condition of the sand grains. It was also a fact that, in addition to being ineffective, the separation methods are not economical, especially when water is used, because an abundant supply must be available. It is also necessary to again dry the water-separated sand, and this is not only expensive, but the drying requires careful super-

vision to preclude the possibility of the reclaimed sand being heated to a temperature which would destroy its usefulness.

As conceived in both the ideal and practical theory, the centrifugal air scrubber is based on the idea that reclamation of moulding sand is primarily a process of cleansing the grains of sand by removing from their exterior surface all adhering particles of foreign matter.

The principal function of the centrifugal air scrubber is to break up any changing masses or combinations of sand grains, and then cleanse them of adhering foreign matter. This method used is called "air scrubbing."

In addition to the scrubbing equipment development, the problem of a proper dust arrestor was one of the most important which had to be solved. The centrifugal air scrubber and separator equipment are shown in Figs. 3 and 4.

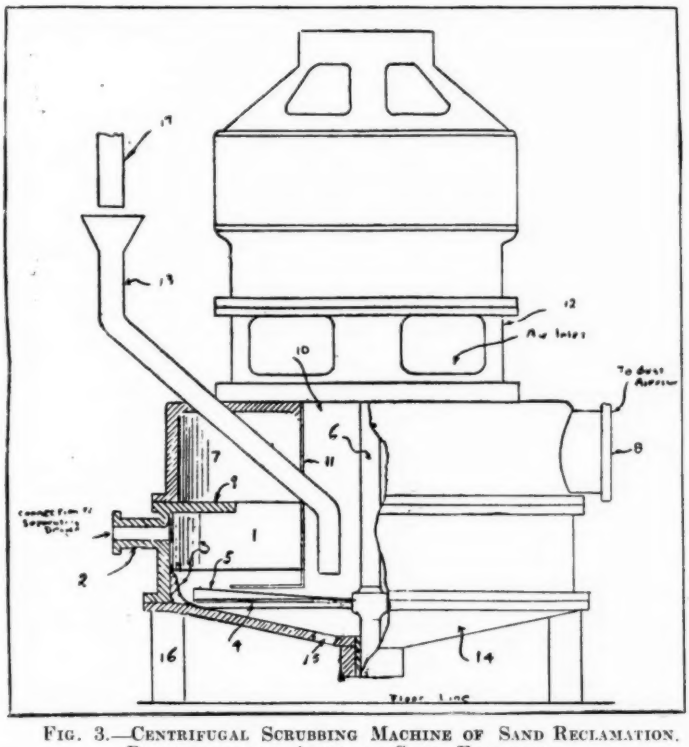


FIG. 3.—CENTRIFUGAL SCRUBBING MACHINE OF SAND RECLAMATION. PATENTED BY THE AMERICAN STEEL FOUNDRIES.

1. Main scrubbing chamber. 2. Outlet for sand to separating device. 3. Wearing ring (replaceable). 4. Fan disc. 5. Fan blades. 6. Driving shaft for disc 4. 7 Auxiliary drum-serving as a dust separating device. 8. Opening for carrying off dust-laden air. 9. Horizontal flange which serves as separating baffle. 10. Opening from drum 7. 11. Pipe to carry air down. 12. Motor stand. 13. Feed pipe. 14. Bowl shaped bottom to accumulate surplus sand. 15. Hole for automatic removal of surplus sand. 16. Stand. 17. Connection to separation device. 18. To dust arrestor. 19. Air inlet.

Explanation of Operation of Centrifugal Sand-Scrubbing Device.

Sand passing to the scrubbing chamber (1) by means of feed pipe (13) is whirled around the side wall of the chamber by means of the air current set up by the revolving fan blades (5). The sand grain travelling in a circular passage around the walls, rubbed clean by the action against the walls and other sand grains, gradually rises up to openings (2) passing over to the separating device. The dust particles are drawn off to chamber (7) and out to dust arrestor through opening (8). Air is carried into chamber (1) through pipe (6) from openings in the motor stand. Surplus sand is automatically removed through opening (15) in the bowl-shaped bottom (14).

Explanation of Operation of Sand-Separating Device.

The scrubbed sand enters the device through opening (1), and falling on to plate (3), is spread out to width of plate. The stream of sand then falling down in front of flight plates (4), the grains of sand are forced up the inclined plates by the current of air through inlets (5). Starting to roll up the flight plates, the heavier sand grains lose their momentum and roll down, falling to bottom of the apparatus and into opening of storage hopper (8). The finer particles continue on up the flight and fall into section 6, where they accumulate and are drawn off through cleanout door (7). Any dust is taken out through passage (2) to dust arrestor.

The size of sand grains retained is controlled by adjusting the slope of the flight plates (5). The greater the angle of slope the finer the grains retained, when a constant air force is used.

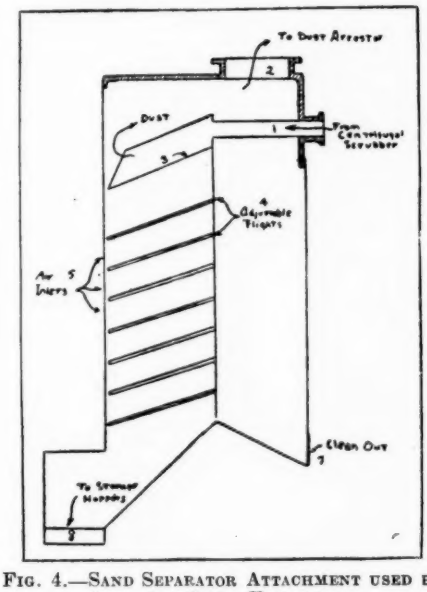


FIG. 4.—SAND SEPARATOR ATTACHMENT USED BY AMERICAN STEEL FOUNDRIES.

Cost of Reclaiming Sand by Centrifugal Air Scrubbing Process. (1920 and 1921.)

Actual tests have disclosed that approximately 70 per cent. of the sand treated is returned for

further use. The power required for machines 14.5 kilowatt-hours per ton of sand reclaimed. The reclaimed sand actually required less bonding material than new sand.

One plant had on its books (October 8, 1920) two grades of new sand at 10s. 7d. and 12s. 9d. per ton, as against the cost of 7s. 1d. per ton for reclaimed sand. An investigation showed this time that cost should be reduced by the better handling of gaggers and refuse sand and supplying automatic shakers for screens in dust arrestor. The cost stated includes labour, repairs and power.

A comparison of costs of reclaiming during one month at three plants is as follows:—

	Plant A.	Plant B.
Tons of Sand reclaimed	832	275
Operating hours	474	224.50
Machine hours	666	446.25
Average ton per machine-hour	1.25	0.616

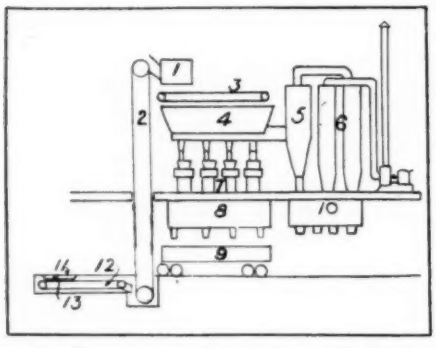


FIG. 5.—DIAGRAM OF PROPOSED SAND-RECLAIMING INSTALLATION.

1=Screen. 2=Sand elevator. 3=Sand conveyor. 4=Screened sand bin of 30 tons capacity. 5=Dust separator. 7=Reclaimer. 8=Reclaimed sand bin of 80 tons capacity. 9=Dump car. 10=Dust bin of 50 tons capacity. 11=Bar screen. 12=Conveyor. 13=Hopper.

The aim at B was to produce a sand in every way as a satisfactory substitute for washed dry sand. The comparative cost of new material and reclaimed sand is:—

	New Moulding Sand.	New Washed Sand.
Cost of new material	$2.65	$3.85
Cost of reclaimed sand ..	1.15	1.15
Saving per ton	$1.50 (6/3)	$2.70 (11/3)

Plant C reclaimed sand cost 3s. 8d. per ton. This sand was not as clean as at Plants A and B, but suited the needs of Plant C.

May 9, 1921.—Plant B costs of reclaiming sand was 3s. 5d. per ton, against cost of new sand at 10s. 10d. per ton.

Proposed Sand Reclaimer Unit to be Installed at One Plant Waste Sand Delivery.

(*a*) Waste sand is transferred from cleaning room in foundry in gondola or dump-cars, and sand is delivered on to a belt conveyor, which discharges the sand over a magnetic pulley into a continuous bucket elevator.

(*b*) Waste sand from knock-out hammers is delivered through a bar screen on to a 24-in. belt conveyor and discharged on to the same conveyor leading from the waste sand screen of item (*a*).

Sand Screen.—The continuous vertical bucket elevator called for under item (*a*) discharges into a revolving cylindrical screen which discharges on to a belt conveyor, directly over the screened sand bin. Over-size material and tailings are delivered at the end of the screen into a chute, which discharges into a box setting on the reclaimer floor.

Screened Sand Storage.—The screened sand is delivered on to a belt conveyor, and is discharged into a screened sand storage bin of approximately 30 tons capacity.

Sand Reclaimers.—Four sand reclaimers are placed on the reclaimer floor or balcony, and are fed from the screened sand storage bin by gravity. Reclaimed sand is delivered into bin supported from the underside of the new reclaimer floor or balcony. Reclaimed sand bin has a capacity of approximately 70 tons of reclaimed sand.

Refuse and Dust Collectors.—The dust and refuse are drawn off from the sand reclaimers by means of a 50-in. fan through an adjustable air separator of ample size, where the heavy dust is collected, the fine dust being collected by means of a suction filter of ample size. The free air is then discharged to the atmosphere. The dust collected by air separator and suction filter is discharged into a dust bin, having a capacity of approximately 50 tons.

Capacities of Sand Reclaimers.

Loading Out.—A car is set alongside of either the reclaimed sand bin or the dust bin for loading 1 ton reclaimed sand per hour per machine. Four reclaimers equal 4 tons reclaimed sand per hour.

Taking 70 per cent. reclamation, the system will handle 5.7 tons of refuse sand per hour. Allowing 4 tons reclaimed sand per hour, the system will separate 1.7 tons of dust per hour, and with three reclaimers running, using the fourth as a spare, there will be reclaimed in one month 1,560 tons. This is based on 20 hours per day and 26 days per month.

With four reclaimers running and a fifth for a spare, there will be reclaimed 2,080 tons of old sand per month.

Catalogues Received.

Cast-Iron Pipes.—The monthly stock list of cast-iron pipes from the Staveley Coal & Iron Company, Limited, of Chesterfield, is now available.

Furnace Castings.—From Messrs. The International Combustion Engineering, of Derby, we have received a brochure entitled "Why Cast Iron Burns." It outlines the properties and uses of, but not the composition of "Usco" alloy, and in an interesting manner describes the factors associated with the burning of grate bars and the like. The following claims are made for the "Usco" alloy:—(1) It lasts three to ten times as long as cast iron, whilst only costing 50 per cent. more; (2) the melting point is materially higher; (3) tensile strength is higher; (4) freedom from cracks in use; and (5) it is a practicable foundry mixture. Apparently, it is the intention of the makers only to supply castings of "Usco" alloy and not the alloy itself for other foundrymen to remelt for their own requirements or orders.

Necol Plastic Wood.

Messrs. Necol Industrial Collodions, Limited (a constituent company of Nobel Industries, Limited), Windsor House, Victoria Street, S.W.1, have appointed the following firms as their district representatives for the sale of plastic wood:—Derrick & Hosegood, Bragg's Lane, Bristol; G. Stephenson & Company, Limited, Northgate, Darlington; R. A. Raphael, 166, Buchanan Street, Glasgow; D. W. Massey & Company, timber merchants, Hull; G. Stephenson & Company, Limited, Round House, Wellington Road, Leeds; Hosking & Callan, 1, Thomas Street, South Castle Street, Liverpool; J. W. Jackman & Company, Limited, Vulcan Works, Blackfriars Road, Manchester; G. Stephenson & Company, Limited, Depôt Road, Middlesboro'; Lawson, Walton & Company, Limited, 2, St. Nicholas' Buildings, Newcastle-on-Tyne; Johnson & Wright, Limited, Gold Street, Northampton; The Fisherton Company, Bamber Bridge, near Preston; James Mudford & Sons, 32, Exchange Street, Sheffield; W. Gath Watkins, 8, Joyce Avenue, Sherwood, Notts; Tividale Tool Company, Merton Road, Watford.

A 60-80-ton Electric Furnace.—At the Ford Motor Company, River Rouge Plant, Detroit, there is under construction a 60- to 80-ton electric furnace, which will be equipped with eight electrodes and transformers of 12,000 k.v.a. capacity. The electrodes are arranged in two rows of four, and each pair and contact plate under the hearth of the furnace—which is common to all—forms an electrical unit and is supplied by a 3,000-k.v.a. 3-phase transformer. The furnace has inside dimensions of 20 ft. 6 in. by 16 ft., and is designed on open-hearth lines, having fire doors giving access to all parts of it, and tilting endwise. All doors are operated by air cylinders, having a definite stroke to prevent overtravel. The furnace sidewalls are 12 in. thick, and the rear wall is given a slight arch. The roof bricks are 12 in. thick, but are thickened somewhat around the ports. Tilting is carried out by a 65-h.p. motor.

An Apprenticeship Course in Foundry Practice.—XLIX.

By Ben Shaw and James Edgar.

CALCULATING WEIGHTS OF CASTINGS. II.

As a general rule it is more necessary in the foundry to ascertain the weight of large castings than of small castings, because it may tax the capacity of the foundry to melt sufficient metal at one heat. When a large number of small castings have to be made the foreman is usually able to make a rough guess at the approximate weight of metal that will be required. It is not altogether a guess, but a mental calculation such as was described in the previous article on the subject. Foremen take a pride in having as little metal as possible run to waste after a cast. As already pointed out, mensuration is invaluable—indeed, indispensable—when working out weights of castings, and without a knowledge of the development of surfaces the apprentice will never succeed in estimating weights of intricate castings. On the other hand, one must not become a slave to theory in the workshop, and in the case of many quite awkward castings the weight can be worked out very accurately by dividing up and averaging. The apprentice must accustom himself to the breaking up of work into simple sections, calculating the number of cubic inches in each part, and then adding the measurements of the various items. Having obtained the number of cubic inches, or square feet at a definite thickness, they can be converted into weight by means of a multiplier. In castings of very irregular shape very great accuracy is not possible, but a mean approximation can be obtained.

Makers of propellers, pile screws, and toothed wheels have special formulæ for obtaining weights. In the case of wheels there are tables which are fairly accurate. It is not proposed, therefore, to explain the methods of calculating weights of these castings here, but to take simple work, from which the student, after mastering it, can proceed to more difficult by himself.

Bent Levers.

A simple casting is shown at Fig. 1. It represents a bent lever of cast iron. Castings should be divided into sections, and whenever possible the student should divide into squares and rectangles. It will be most convenient to calculate the cubic measurement of the middle plate or trapezoidal rib, and afterwards the measurement of the bosses. As the distances D and E are equal, and the two end bosses are also of equal diameter, in order to find the area of the centre plate we must take a mean between the diameter of the centre boss and the diameter of the two end bosses and multiply by the thickness. Thus, if the centre boss is 4 in. dia. and the end bosses are 3 in., the cubic measurement of the plate would be (D + E) × 3½ in. × A, say = W. As all the end bosses are of equal diameter, and assuming the total thickness is 2½ in., it is found by reference to a table of areas of circles that the area of a 3-in. circle is 7.0686 sq. in., which must be multiplied by the thickness, thus: 7.0686 × 2½ in., say = X. As the cubic measurement of the centre plate was only obtained to the centre of the end bosses, it is necessary to find the area of two semi-circles. This is equal to 7.0686 × A, say = Y. The centre boss L is 4 in. dia., therefore the volume equals 12.566 × (C + C), say this = Z. The weight of the casting therefore is (W + X + Y + Z) × 0.263, which is the weight of 1 cub. in. of cast iron.

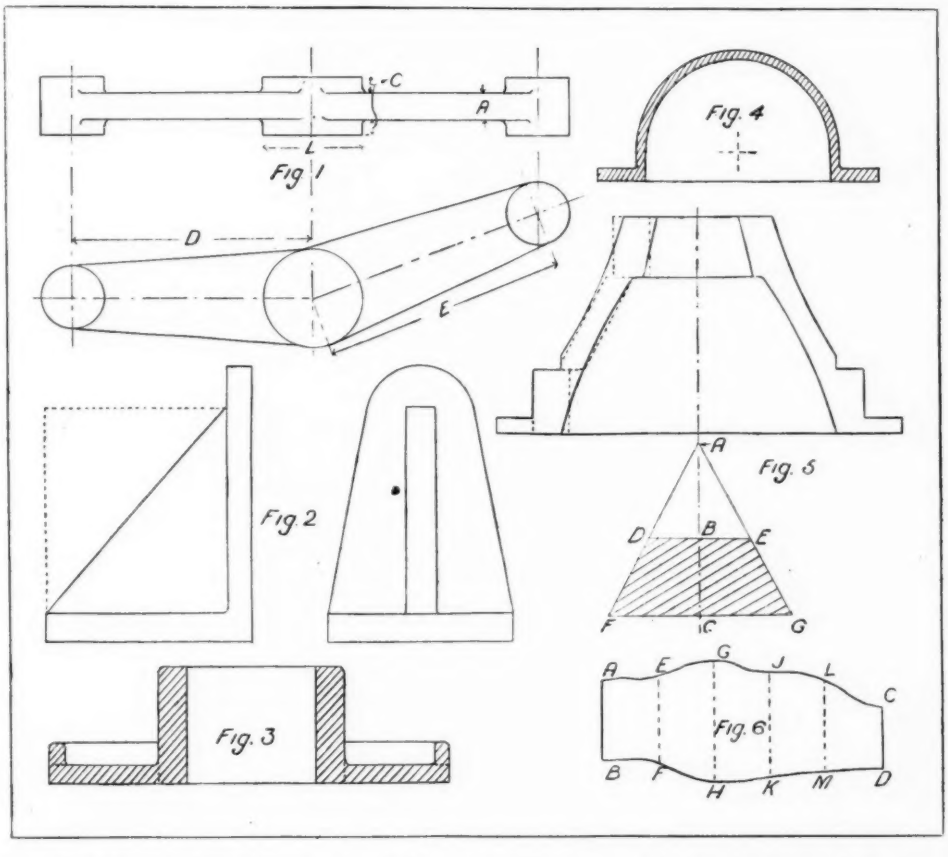


Fig. 2 represents a cast-iron bracket of very common design. It does not present any difficulty,

but it emphasises the advisability of connecting sections into rectangles for purposes of calculating. The dotted line indicates the completion of a rectangle enclosing the rib between the base and the vertical face. It is not any simpler to obtain the area of a rectangle and dividing by two, because this is actually what is done when finding the area of a triangle.

Couplings.

The coupling shown at Fig. 3 is a simple example of a cylindrical casting. The usual method is to find the area of the whole surface, then the area of the core, and deduct the latter area from the former. In the case of the coupling the dotted lines show the most convenient places to break it up. The volume of the body is found by multiplying the area by the length and deducting the volume of the centre core. By the same procedure the volume of the flange and the rib behind the flange are found. The total volume is the sum of the three calculations, and this multiplied by 0.26 gives the correct weight in lbs. for an iron casting.

A flywheel has to be very carefully calculated, and the work is not always done in the drawing office. Even when a replacement casting is required it is most important, unless instructions to the contrary are received, that the new casting should be as nearly as is practically possible the same weight as the old casting. We shall now consider briefly a large flywheel. A small percentage might be added for fillets, or they might be ignored. On a great many patterns there are a number of rounds that compensate more or less; therefore, unless extreme accuracy is desired, or the fillets are very large, it is frequently quite unnecessary to consider them when calculating weights. With a flywheel the lines indicate a suitable method of breaking it up, and this method also applies to pulleys. The weight of one arm is obtained and this is multiplied by the number of arms. The elliptical-shaped arms do not constitute a difficulty, because the area of an ellipse is obtained in a similar way to a circle, except that instead of squaring the diameter the axes are multiplied together and the product multiplied by 0.7854. If the ellipse is measured on a line midway along the length of the arm, this area multiplied by the length will give the approximate volume. The boss is calculated in a similar manner as in the previous instance—by subtracting the volume of the core from the volume of the outer diameter of the boss—but, with the rim, it is better and easier to find the sectional area and multiply by the length of the circumference of the centre of the section.

Dome-shape Castings.

There are many dome-shaped castings similar to Fig. 4. We know that the volume of a sphere equals the cube of the diameter multiplied by 0.5236, or, alternatively, it equals $\frac{4}{3} R^3 \times 3.1416$ where R equals the radius of the sphere. Knowing this, it is a simple matter to find the volume of half a sphere, and if the volume of half a sphere is obtained, and that of the flange, the remainder is a narrow cylindrical portion which can be obtained as already explained. A table of the weights of cast-iron balls may help considerably here. If the weight of a hollow sphere is wanted, the weight of a ball corresponding in diameter with the interior of the sphere is deducted from the weight of a ball corresponding to the outer diameter. Half of this will, of course, give the weight of a semi-spherical body. When the work is comparatively large the quickest and most satisfactory method is to consider the domed shape as a flat circular plate, the diameter of which will be equal to the length represented by the domed shape. When the dome forms a complete half-sphere, then the diameter of the flat plate would be equal to half the circumference, but domed covers of this kind are rarely semi-spherical. A suitable method for the workshop is to use any flexible material to find the length of the arc forming the dome. A wood lath may be used, or, if the curve is too quick, then leather belting, canvas, brown paper, or even string may be used if care is taken so that it is not stretched, the length thus obtained being used as the diameter of the plate. This method is not strictly accurate, but it gives a close approximation, especially if the domed shape is comparatively flat.

Pistons.

More difficult is the piston shown at Fig. 5. The most practical way of finding this volume is to ignore curves. The calculations necessary to find the volume if curves are considered would be involved, and at the finish the weight would probably not be more accurate. The only difficult part is the measurement of the conical section. It is not correct to find a mean diameter from which to obtain the area and multiply by the length for the volume, but it is useful if only an approximate weight is required. The conical part forms the frustrum of a cone, and to find the volume of such a body, represented by D E F G in Fig. 5, it is profitable to produce F D and G E to obtain the height of the apex at A. Then the formula for finding the volume would be

$$\frac{CG^2 \times 3.1416 \times AC}{3} - \frac{BE^2 \times 3.1416 \times AB}{3}$$

The use of this formula necessitates considerable calculation, seeing that both the inner and outer volumes need to be found in order to find the volume of metal. Generally it is much more convenient to consider the conical surface as a flat plate equal in thickness to the metal in the casting. This is readily found by multiplying half the sum of the diameters by 3.1416 and the product by the slant height of the frustrum. When this area is found it is not difficult to obtain the weight of the conical part.

Engine Columns.

It is as easy to calculate the weights of large work, like engine columns, as of the small castings that have been discussed; nor is it very difficult to find the weight of either a piston valve or a slide valve, but it does require time and patience. It is much better to divide a design into too many than too few different parts, and, when calculating, curves can be obviated by striking a straight section to correspond with it approximately. Experienced men devise ingenious methods for particular jobs. Thus the volume of the curved arms of a pulley may be calculated in the following manner: Between the outer rim and the centre boss the arms constitute a segment of an elliptical ring. Some craftsmen, after obtaining the area of the ellipse, would then find the area of the whole diameter, and by dividing this with the length of segment would obtain the volume of each arm. The quicker way is to measure the length of one arm on the centre line with the aid of a thin lath or steel rule. This is a satisfactory way of dealing with many curved shapes.

General Calculations.

The basis of all calculations for weights is the circle, the cylinder, and the parallelogram, and to which might also be added the cone, and the apprentice should memorise methods for finding the area and volume of these figures. To find the area of a rectangle or any parallelogram the base must be multiplied by the altitude and the product will be the area. In the case of a triangle the base is multiplied by the altitude and the product divided by two, but usually it is more convenient to multiply the height by half the length of the base. It must always be remembered that when inches are multiplied by inches the product is square inches. With an irregular polygon it is necessary to divide it into triangles, obtain the products, and add together for the whole area. The practical man whenever possible dispenses with the use of Simpson's rule, but it is sometimes almost necessary, as when a shape rapidly changes and it is almost impossible to average the area otherwise. By this method the shape is divided into a number of parallel strips of equal width, as shown at Fig. 6, then the area of the shape is obtained by the use of the following formula, the sum of the first and last ordinates divided by two, to which is added the sum of all the other ordinates and the whole multiplied by the width of one strip. Thus area equals

$$\left(\frac{AB+CD}{2} + EF+GH+JK+LM\right)\frac{L}{n}$$

where L equals the length of figure between A B and C D and n equals the number of strips.

Short Cut Methods.

The weights per cubic inch for cast iron, brass, steel, and aluminium are 0.26, 0.31, 0.28, and 0.097 lbs. respectively, but these are not very convenient for rapid calculations. For cast iron it is better to divide the number of cubic inches by four to give lbs. weight, adding 1 lb. for every 100 cub. in. For brass the divisor should be three, and in this case 2 lbs. for every 100 cub. in. is subtracted. The divisor for aluminium should be 10, and this will give a close approximation of the weight, because ordinary commercial aluminium is more nearly 0.1 lbs. per cubic inch. For steel, seven may be used as a divisor and the result multiplied by two. Frequently the weights of castings are calculated from the weight of a square foot of the metal. Thus for large work it is more convenient to find the number of square feet of area and, according to the thickness, multiply by the weight per square foot. The weight of a square foot of cast iron 1 in. thick is 38 lbs., for brass 46 lbs., for steel 42 lbs., and for aluminium 14½ lbs., but these are usually increased in the foundry to give a margin of safety.

While it is true that many moulders are able to give a very close approximation of the weight of a casting without any apparent calculation, and frequently without putting a rule on the job, this somewhat uncanny skill is the result of years of experience, and all that have experience are not able to judge the weight with any degree of accuracy. It is therefore safer, as a rule, to back up your judgment by calculation.

Jointing Materials for Silica Refractories.*

BY MISS D. JONES, B.SC., AND W. EMERY.

In many operations, notably in those processes connected with the metallurgical industry, the masonry is subjected to relatively high temperatures, and in some cases these temperatures approximate closely to the softening points under load of silica refractories. In structures used for coal distillation, etc., the temperatures are not so high; but the masonry, particularly in modern coke ovens, is subjected to rapid thermal changes. Naturally, this affects the expansion or contraction of the chamber. In some cases the effects are more pronounced in connection with the cementing than with the brickwork, and the following work was undertaken with a view to determine the most suitable jointing materials for silica refractories. It may be added that the more nearly a jointing cement approaches in chemical composition and physical behaviour that of the bricks with which it is used, the more satisfactory are the results obtained.

Experiments were devised to examine the effect of mixing, in various proportions, fireclay, ganister, and crushed silica brick (grog), and in some cases the effect of the addition of certain compounds—such as plaster, lime, and sodium silicate—to these mixtures was likewise investigated. The materials were first thoroughly mixed in the dry state, for a more intimate mixing is in this way obtained. Water was then added to the mixture until a suitable consistency was given. A layer (about 3 in. in thickness) was spread between two blocks (2 in. cubes) prepared from handmade silica bricks. When air-dryed, the test specimens were fired to cone 16 in an electric furnace under a load of 50 lbs. per sq. in. The temperature was raised, over a period of three hours, to cone 16 and then maintained constant for one hour. In order to provide a more severe test, some of the mixtures were re-heated to cone 20 under the same load. In order to obtain information as to the properties of the cements, as distinct from their jointing efficiency, the mixtures were made into briquettes, which were tested for contraction or expansion, crushing strength, and resistance to slag penetration.

The results show that mixtures of fireclay and ganister have much greater expansions than those of clay and grog, but, on the average, these mixtures have a greater crushing strength and offer much more resistance to slag penetration. Although the jointings of the clay-ganister mixtures lack adhesive power, they are very hard and firm as compared with those of the clay-grog mixtures, which are deficient in mechanical strength and are crushed out when fired under load. Mixtures of clay and grog, and particularly those having a large proportion of the latter, are badly attacked by the slag. These briquettes have open textures with large pores, into which the slag freely penetrates. Clay-ganister mixtures sinter more readily than those of clay and grog; and a clay-ganister mixture 1:1 softens so much, when heated to cone 16 under load, that the cement is squeezed out.

It seemed from the above observations that the best results would be obtained by the admixture of fireclay, ganister and grog, and this was found to be the case. Mixtures of the three ingredients, having either equal or greater proportions of ganister to grog, gave very good jointings. These mixtures sintered sufficiently to render the cement compact and firm. A high proportion of grog, however, renders the cement mechanically weak.

In two mixtures a fat, plastic ball clay, instead of the ordinary fireclay, was added in slip form. One was found to be exceptionally good in all respects. On comparing this with a mixture where fireclay was used, the ganister and grog being in the same proportions, the mechanical strength was more than doubled, while the resistance to slag penetration was greatly increased. The jointing was very hard and firm; and even when fired to cone 20 the cement was still good.

To satisfy the requirements which have been indicated as necessary for a good cement, it seems that it is better to have a greater amount of ganister than grog so far as the material is concerned; while for the bonding material a small proportion of a highly plastic refractory clay is more satisfactory than a large proportion of a fireclay of a less plastic nature.

* From a Report of the Refractory Materials Committee presented at the annual meeting of the Institution of Gas Engineers at Belfast.

Canadian Pig-Iron and Steel Production in May.

The production of pig-iron in Canada in May was 101,533 tons, which is the largest monthly total since October, 1920, and exceeds by 23,363 tons the output for May last year. The production of steel ingots and castings during May was 104,079 tons, as compared with 92,598 tons in April, and 17,000 tons only in May, 1922. The total steel production of the first five months of 1923 has been 380,263 tons, as against 144,275 tons in the corresponding period of last year.

Forges et Acieries du Nord et de l'Est.—An extraordinary meeting of shareholders of this company has been called for July 13 in connection with the proposed increase of capital to 77,425,000 fcs. (about £3,000,000 at par). Of the increase, a sum of 8,575,000 fcs. will be placed to reserve, and 24,000,000 fcs. offered in the form of shares to existing holders, at the rate of one new share for every three original shares held. The price of issue will be 275 fcs.

The Chilean Ironworks.—The report for 1922 of the Société des Haut Fourneaux, Forges et Aciéries du Chile, submitted at the recent annual meeting held in Paris, stated that the Corral iron and steel works had not yet been started. In fact, the economic and financial crisis through which Chile was passing had prevented the mission sent out by the Company from obtaining practical results. Pending the conclusion of an agreement with the Chilean Government the Company had further reduced the expense of maintaining the works. The working of the iron ore mines of Tofo had continued, and during 1922 the Bethlehem Company exported 297,000 tons of ore. Unfortunately violent earthquake shocks, accompanied by an inrush of water, took place in November, and brought about a catastrophe in the district where the mines were situated, the railway at Tofo having been seriously damaged and traffic suspended for some time. The Bethlehem Company's lease of the mines had been extended to 1933. It was added that the action instituted in Chile to secure the recovery of the Vallenar Mines was now before the Court of Appeal of La Serena.

XUM

Refining Reactions in Basic Electric Steel Furnace Practice.

By J. A. Holden, M.I.Brit.F.

As steel borings, turnings, millings, etc., are used in considerable quantities in electric furnace practice, the effect of corrosion of such material is a matter of great importance. Piled in the open and left for a time, the outside crust of a heap of turnings will eventually become completely oxidised. If exposed sufficiently long the whole heap may lose its metallic properties and become a mass of iron oxide. The iron content, although difficult to compute because of the sampling required, may be ascertained by fully examining numerous samples. In very dirty material the iron will often fall to about 85 per cent. In one case the writer found it to be only 78 per cent. This scrap was used for ferro-silicon manufacture, and the furnace log showed an extraordinary low iron-reduction, thus confirming to some extent the percentage computed from numerous analyses.

The effect of excess of oxides in the molten charge is never totally eliminated; it is a prime cause of cracked ingots, and it leaves the steel with heavy slag inclusions. The effect upon the furnace is equally disastrous, for the thin watery slag rich in ferrous silicate eats away the furnace banks, and because of its poor heat insulation properties it leads to excessive current consumption, with the attendant increased wear upon the roof. Additionally, the mirror-like character of the slag reflects the arc-rays and is a direct cause of roof destruction.

With very rusty scrap it is obvious that no addition of mill scale or iron ore should be made unless it is known that there are elements present such as carbon, manganese, or silicon sufficient to reduce the excess of ferrous oxide. Generally it is advantageous to add anthracite duff or other suitable form of carbon with the scrap, and thus prevent over-oxidation. A mathematical calculation, assuming the anthracite to be 60 per cent. effective, has proved to be a good basis.

Various amounts of ferrous oxide in the melting slags of different charges are reflected by the consumption of deoxidisers during finishing off. Table I. gives an indication of this; the two heats referred to in that table were melted under almost identical conditions, the only difference was the type of scrap.

TABLE I.—*Heroult Furnace (Basic) 600 K.V.A. Charges, 4,000 lbs.*

Heat No.	187	189
Steel	0.90 per cent. carbon.	0.85 per cent. carbon.
Charge	Badly rusted turnings.	Very clean turnings.
	Silicon —samples minute	Content— at five-intervals.
	Per cent.	Per cent.
1st After fusion of the 2nd slag	0.035	0.035
2nd 5 lbs. 25% ferro silicon added	0.050	0.047
3rd " " "	0.047	0.066
4th " " "	0.120	0.100
5th " " "	0.070	0.130
6th " " "	0.130	0.160
7th " " "	0.070	—
8th " " "	0.080	—
9th " " "	0.070	—
10th " " "	0.099	—
11th " " "	0.140	—
Total ferro silicon used	50 lbs.	25 lbs.

Lime Content of Primary Slag Important.

By comparing the ferrous oxide content of the melting slag with the ferro-silicon consumed during finishing off, it is invariably found that charges melted under very oxidising slags are difficult to kill. This is particularly noticeable if the melting slag is deficient in lime. In this connection it is perhaps not necessary to add that the timely addition of sufficient lime will not only prevent delay in finishing, but it will also prevent such serious defects as cracked ingots.

Before dealing with the finishing-off stages, it may be of interest to consider the migration of the phosphorus. It is sometimes noticeable that the pit sample contains more phosphorus than the bath sample. This to some extent is to be expected, and was dealt with in a Paper by Mr. V. C. Faulkner before the Association Technique de Fonderie,* and no doubt the reduction of phosphorus from the hearth and banks of the furnace, and from the remnants of the melting slag, occurs simultaneously with deoxidisation. During a run upon a small Héroult furnace, the writer observed that many of the pit samples showed considerably more phosphorus than the bath samples. The results tabulated in Table II. show the gradual increase in phosphorus, which takes place as the deoxidisation proceeds. It should be pointed out that the furnace was running on scrap rather higher in phosphorus than the usual practice. The cast 1,865, which shows such a large increase, was slagged off badly.

TABLE II.—*Outlining the return of the Phosphorus to the Bath. Plain Carbon Steels. Approximately 0.80 per cent. C. and 0.30 per cent. Mn.*

Cast No.	Sample.	Si.	P.	P. before Slagging.	P. in Pit Sample.
		Per cent.	Per cent.	Per cent.	Per cent.
	1	0.035	0.022		
1862 ..	2	0.103	0.025	0.020	0.028
	3	0.159	0.025		
	1	0.037	0.013		
1863 ..	2	0.103	0.018	0.011	0.019
	3	0.150	0.019		
	1	0.056	0.015		
	2	0.103	0.022	0.019	0.027
1864 ..	3	0.131	0.023		
	4	0.178	0.026		
	1	0.037	0.022		
1865 ..	2	0.103	0.027	0.015	0.039
	3	0.243	0.033		
	4	0.252	0.037		
	1	0.042	0.021		
	2	0.108	0.022		
1866 ..	3	0.162	0.026	0.012	0.033
	4	0.197	0.030		
	1	0.037	0.011		
	2	0.060	0.014		
1868 ..	3	0.090	0.017	0.011	0.021
	4	0.206	0.020		

During the finishing-off stage in basic electric furnaces it is common practice to use ferro-silicon to secure sound steel, and pouring samples are intermittently taken until "dead" melted steel is obtained. The exact reactions may be questioned, but it is fairly safe to assume that ferrous silicate is ultimately formed, and that part of the ferrous silicate may be retained by the steel as a slag inclusion.

It is as well to remember that when steel is analysed the silicon return includes the amount in combination as ferrous silicate. This point should not be lost sight of, and it is desirable at times to make a microscopical survey in order to decide whether the silicon is primarily in solid solution in the steel or present as a silicate in slag inclusions.

From the foregoing it follows that when steel is required practically free from slag inclusions, dead melting by means of ferro-silicon additions cannot be adopted. Calcium carbide has often been accidentally formed during the finishing stages; the carbon added to the slag to remove ferrous oxide has been excess, and reacted with the lime forming carbide.

It has been observed that steel made under such conditions has given very dense ingots, and incidentally the sulphur content has been very low. It is supposed that the sulphur (ferrous or man-

* See "Foundry Trade Journal," Vol. 27, No. 345.

ganous sulphide) is readily attacked by calcium carbide; but this is not a very important consideration. No doubt some of the properties of steel made under a carbide slag have been attributed to desulphurisation, whereas the efficacy of the carbide as a deoxidiser has not been appreciated. By refining under a slag rich in calcium carbide it is possible to secure dead-melted steel with only a trifling addition of ferro-silicon.

Two Oxidising Slags Sometimes Necessary.

Certain precautions have to be adopted before the proper conditions can be secured. During melting an excess of oxide must be avoided. If the charge is rich in phosphorus it is preferable to pour off the melting slag and dephosphorise with a second oxidising slag, rather than feed in large additions of mill scale or iron ore. In fact, the writer has made many tons of ingots without adding iron ore, mill scale, or other oxide of iron. It is necessary to skim off rapidly and thoroughly; the hotter this can be done the less oxide left in the steel.

If mild steel is called for it is better to add calcium carbide after the fusion of the finishing slag; but for higher carbon steel the carbide may be formed in the furnace. Lump calcium carbide is not easily fused; it is therefore advantageous to crush it.

After the addition or formation, as the case may be, every hole round the furnace doors should be luted, and a carbon-depositing atmosphere secured within the furnace. The time required to deoxidise each charge will vary, but generally it will take not less than 30 minutes. Operating 7-ton charges in a furnace of 1,200-k.v.a., and adding 30 to 40 lbs. of calcium carbide, the writer has regularly "killed" the steel in one hour. A final addition of ferro-silicon equal to 0.05 per cent. silicon is necessary. If the refining has been successfully carried out, the resulting ingots will contain practically the whole of this silicon addition.

Steel made in this manner, if properly handled, *i.e.*, using clean ladles, well prepared moulds, etc., will meet very exacting specifications, and will rarely show slag inclusions.

The use of calcium carbide may suggest very erratic carbon percentages in the steel. In practice, however, this does not often happen. The writer has not applied it for the production of softer steels than 0.18 to 0.22 per cent. carbon. By slagging off with the bath at about 0.10 per cent. C. and allowing 0.04 per cent. C. from the manganese addition, the ingots contain from 0.18 to 0.22 per cent. of carbon. That is, when adding the carbide of calcium. If, however, the carbide is formed in the furnace, there is a larger absorption, usually about 0.10 to 0.13 per cent.

A Simple Moulding Machine.

Whilst some may disagree that pattern drawing machines are moulding machines, the concensus of opinion is that where total time of moulding is reduced by mechanical means, these devices can reasonably be termed so. Of British types, one of the most popular is the one we illustrate below. It is manufactured by Messrs. Darling & Sellars, Limited, of Keighley. Being hand-operated, the entire cost of compressed air, hydraulic power or electric current are eliminated, as are also piping and belting. Several sizes are made, taking boxes ranging from 2 ft. up to 6 ft. square, but even this is not the maximum, as the manufacturers make tables of sizes to suit the users' requirements. The foundations are of an inexpensive character. An example of its operation is shown in the illustration, where the pattern to be moulded is a flywheel. Half the pattern is attached to the pattern-plate A. The moulding box is put in position on the plate, and sand is rammed up in the usual way. The bottom plate and bottom box is clamped to the table, and the catch B is released and the load rotated through a half-circle by worm gearing actuated by the hand wheel C. The catch B is again placed into position, but this time on the reverse side of the plate. This maintains the plate both rigid and level, with the box attached to the under side of the plate. The table D carrying the plate E is raised by the racks F, which are controlled by the wheel G until it engages the plate on the box. The catch is released, and by reversing the direction of the wheel G the mould is lowered from the pattern, the table coming automatically to rest, when the upper surface is in contact with the plate H. The plate E supporting the box is then brought forward, the mould removed, and is returned to its normal position on the lifting table.

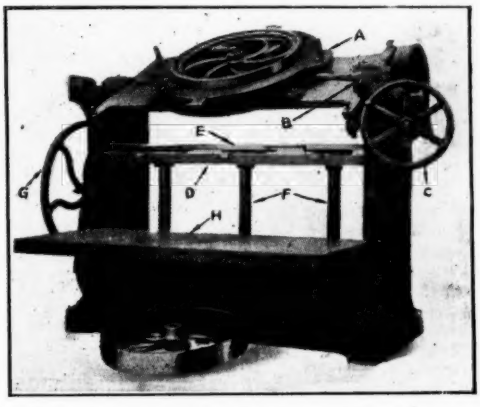


FIG. 1.—A ROLL-OVER PATTERN-DRAWING MACHINE. MESSRS. DARLING AND SELLARS, LIMITED.

The roll-over table is put back and fastened in the position for ramming, and the machine is ready for a second mould. The manufacturers claim that a No. 2 machine is capable of putting down 50 complete 18 in. by 12 in. by 3½ in. deep boxes of two parts in a normal working day.

Centrifugal Pipe Casting.

Inspection by the Staffordshire Iron and Steel Institute.

On Wednesday (June 20) the Staffordshire Iron and Steel Institute accepted an invitation from the directors of The Stanton Ironworks Company, Limited, to inspect the pipe-casting operations now carried out at their Works on the centrifugal system. The party comprised nearly seventy members, who were conveyed from Birmingham in special saloons to Stanton Gate Station and thence to the Works in motor coaches provided by the Company. The visitors included Mr. F. J. Cook (President), Messrs. J. Payton, F. Somers and I. E. Lester (Past Presidents), J. Piper (Treasurer), and C. B. Pugh (Secretary). The visitors witnessed the pouring of the metal and the subsequent transference of the pipe to an annealing furnace. The system has been in operation now for about twelve months, and the Company are producing pipes from 4 in. up to 15 in. diameter, but they report that successful experiments have been made with much larger diameters—up to 6 ft.

Following the inspection the party were entertained to luncheon in one of the Works canteens.

MR. E. J. FOX (managing director), in welcoming the visitors as "fellow-workers in the iron and steel trades," said that the Stanton Company were the first to take up centrifugal pipe casting on a large scale in this country, and the United States, among other countries, had followed suit. Among the recent users of the system were France, Belgium and other Continental countries. The possibilities of such casting were far beyond the limits of 15 in. diameter, and nothing seemed more certain than that the old method of making cast-iron pipes would gradually become extinct. They were using the same quality of pig-iron as under the old system, and getting a tensile strength of 20 tons against 9½ tons, which was the British Standard Specification for ordinary cast-iron. A large business was being done in concrete pipes adapted primarily for lower pressures. When higher pressures were called for it was necessary to utilise wire reinforcement. The ordinary iron or steel pipe thus fitted with a "concrete stomach" was becoming popular with hydraulic engineers, in view of the protection thereby afforded from the effects of chemical action upon the iron. In connection with the Birmingham water system these pipes had been largely used, and similar work had been done for Liverpool, Manchester and Leeds.

THE PRESIDENT (Mr. F. J. Cook), proposing a vote of thanks for the hospitality extended, complimented the Company on their courage and enterprise in carrying out these developments. The visitors appreciated also the broad-mindedness of the Company in letting them see and fully explain what they were doing.

The Manufacture of Steel Castings in the United States.

By Major R. A. Bull,

Research Director, Electric Steel Founders' Research Group, Chicago, Ill., U.S.A.

Exchange Paper on behalf of the American Foundrymen's Association, Manchester Conference, June 13, 1923.

(*Continued from page* 530.)

Mouiding Sand.

In any general discussion of steel foundry practice in the States, or indeed elsewhere, reference of appropriate length to the subject of moulding sands is advisable.

Contrary to the condition in the British Isles, American steel foundries in the great majority of cases use synthetic sands, the base of which is generally a sand having rounded grains, analysing from 94 to 99 per cent. silica. Very large deposits of such sand are found in numerous locations in the eastern and middle-western states. In the extreme eastern section there has been developed a deposit of sand sufficiently high in silica content, and yet carrying sufficient natural clay of the desired qualities to make the sand suitable for some steel moulding purposes without the supplementary introduction of any ingredient that Nature has not supplied. This deposit is of very unusual character as compared with American sands in general. In the extreme West there have yet been developed practically no sand deposits of consequence seemingly well suited to steel foundry operations.

The conditions referred to have necessitated much attention to the design and operation of sand-mixing equipment. Such equipment consists of two general types, one being that of the pan, with revolving mullers or rollers, the other being of the barrel type, horizontally set up, with paddles or blades revolving on a shaft extending the length of the cylindrical shell. The pan type of mixer is much the more common one in use. The pan itself is circular, generally varies from 6 to 10 ft. dia., and is sometimes stationary, while at other times it is revolved. In most cases two mullers with intervening ploughs are employed. These mullers are of varying width, and as applied have flat treads unlike some found abroad.

Elevating hoppers are now used with many pan-mills for receiving the ingredients of the sand-mix while a charge is being milled in the pan. As soon as the pan is empty, the hopper into which the ingredients have been introduced is mechanically lifted and dumped into the pan for mixing. In some types of mills that have stationary pans, the sand, after mixing, is quickly dumped through an opening in the bottom of the pan, which is closed by a hinged door during the mixing operation. In certain kinds of mills with stationary pans a section of the pan-side is made as a hinged door to serve the same purpose. Where the revolving pan is used, an adjustable plough is often introduced over the side of the pan to deflect the milled sand and empty it over the side.

Milling time in the pan ordinarily consumes not less than three nor more than ten minutes per batch, but is rarely regulated by the clock. In most cases the mill operator regulates the time for the operation by a "fist-test," or by the apparent strength and moisture of the mix as his sense of touch permits him to judge.

In most American steel foundries a fairly large percentage of the old or "heap sand" is used in the regular "facing," or sand prepared for ramming directly against the pattern. The portion of such used-sand in the facing varies in accordance with the class of work being produced and the ideas the individual foundryman has as to the proper composition of the mix. His judgment is influenced partly by the delivered cost of new sand, or, in other words, by the proximity of his source of supply. Probably the proportion of heap-sand used in most American steel foundries for the general run of work produced, ranges from 25 to 50 per cent. Despite this extended use of old sand, more than 50 steel foundries answering a questionnaire recently reported consumptions of new sand that averaged 1,400 lbs. per net ton of castings produced.

Fire-clay is also universally used for imparting cohesiveness to the mixture intended for facing. There are many clays in use that are quite suitable for this purpose whose melting point will average 1,500 deg. C. Many clay producers who serve steel foundries have in recent years delivered their product in a finely pulverised condition, to the great advantage of the steel casting industry. It is generally recognised that a dry binder is most effective when added to the sand in a finely divided condition.

There is frequently added to the facing mixture some farinaceous product, generally made from corn or wheat, which has cohesive value, and at the same time is generally believed to impart "peeling" properties to the face of the mould. An opinion held is that this material goes into rapid combustion when in contact with the molten steel, and that a gaseous envelope is formed by this combustion, which tends to protect the less refractory ingredients in the face of the mould, to the final advantage of the casting, from which the sand is believed to strip or peel more readily.

To temper the facing in the mould, water alone is added, or water thickened with a small proportion of molasses or a substitute therefor. This substitute is purchased under various trade names, and is generally a by-product of the wood pulp industry. Its bonding strength is about one and one-half times that of molasses when used in conjunction with silica sand.

During the last few years a great deal more attention has been given the study of moulding sands for all foundry purposes in America than was formerly the case. The most significant development in this study has been the formation of the Joint Committee on Moulding Sand Research, organised by the American Foundrymen's Association, with the active co-operation of the National Research Council, the American Society for Testing Materials and various Government bureaus and departments, including the Bureau of Standards. This committee includes representatives of every phase of industrial and scientific work which is related to the subject. During the last year and one-half the Joint Committee has been vigorously attacking problems related to the testing of moulding sands for the purpose of establishing standardised methods of tests. At this writing, methods for essential tests to determine bonding strength, permeability and fineness, and methods for supplementary determinations relating to dye absorption and complete chemical analysis, are practically ready for tentative adoption for one year's trial throughout the American foundry industry. A comprehensive method of sampling sand has also been prepared. As a result of the Joint Committee's activity, many geological surveys have been planned to develop new deposits of moulding sands. One phase of the Committee's activity of very important character relates to conservation and reclamation. The author suggests the future scrutiny of British steel foundrymen to the Committee's reports to be presented at the 1923 Convention of the American Foundrymen's Association.*

Moulding Equipment.

Descriptions of moulding equipment used at home and abroad, either in the form of technical papers or in circular matter disseminated by sellers of such equipment, have been sufficiently elaborate to make unnecessary extended mention in this Paper.

* This report will be found in Vol. XXXI., to be subsequently issued, of the "Transactions of the American Foundrymen's Association," and is printed elsewhere in this issue.

Considering the widely diversified nature of the steel casting industry, the equipment in its various forms represents a very large number of devices, many of them highly ingenious and extremely useful. Factors which have been properly regarded by the most intelligent manufacturers of such equipment in the States are those of ruggedness and ability to stand the excessive wear to which such devices are generally subjected as part of the equipment in a steel foundry. Wherever it has been practicable to displace manual labour and to substitute therefor a squeezer, pneumatic rammer, jar rammer, or other type of machine for compressing the sand, the substitution has been considered and often effected in the average American steel foundry.

In such foundries specialising in small castings and shanking the metal by means of pots carried by hand, the squeezer machine is an important piece of equipment. For floor work the pneumatic rammer has demonstrated itself to be of much value in a lessening of manual labour and in great flexibility, applicable irrespective of the nature of pattern equipment or the number of moulds to be made from a pattern. The jolt-machine, or jar-rammer, during the last fifteen years has justly become very popular. It was developed many years before that, but for some time received inadequate recognition. Vibrators to facilitate pattern drawing, roll-over devices for the more satisfactory and rapid use of moulding machines, and other improvements in components of moulding equipment, have been developed to very great extent within the last ten years. More recently other types of moulding machines have been patented which are of material assistance not only in ramming but in handling the facing for this operation. Some of these more recently developed items of moulding equipment are of special application to the making of castings requiring a considerable flask area, and ordered in large quantities at one time. Naturally the specialisation particularly significant in the basic open-hearth foundry has reflected itself in the engineering skill wisely directed to moulding equipment for its classes of duplicate work. So successful have been efforts in this direction that superiority of the castings produced has attended rapidity of production. As a simple economical combination for the production of open-hearth specialties in cast steel, the plain stripping machine permitting the pattern to drop through the plate, and the pneumatic rammer represent very common practice in the States.

Related directly to the quicker production permitted by machine moulding are the delivery of the facing and backing sand to the machine, the delivery of flask equipment to the moulders at a speed permitting satisfactorily continuous operation of the machine, and conveyance from the moulders' working floor, of the moulds after finishing and closing. These operations must be satisfactorily synchronised to obtain the full benefit of equipment for rapid moulding. It frequently happens that the delivery of sand and flasks (or boxes) to and from the moulding floor constitute a problem which requires much more thought and a much larger expenditure of money for equipment than are needed for the operation simply of ramming the sand. The extent to which such production problems have been worked out in some American steel foundries devoted mainly to the manufacture of duplicate work, is highly interesting, and indicative of the fact that mechanical engineering has a very large part in the operation of such plants.

In the jobbing steel foundries in the States there has necessarily been less of the development just referred to. However, the average foundryman in such plants is alive to the economical advantage of much moulding machine equipment at present available to him, by means of which he may displace manual labour to a considerable extent in the production of short jobs, or pieces ordered in small quantities at one time.

The development of mechanical devices for moulding in the States has been pronounced during the last twenty years. It has been progressive with each year, but the growth was naturally at an accelerated rate during the world war. It is safe to assume that the design and construction of labour-saving equipment for moulding purposes in America will continue at a rapid rate for a long time to come, and that we will see ten years hence a further significant advance, through the application of great engineering skill now directed to the study of foundry problems.

Core Practice.

The installation of very scientific methods characterising moulding operations has not been paralleled by similar progress in the core room, in American steel foundries. The steel casting industry seems to have laboured under somewhat the same handicap as has afflicted other branches of the foundry industry in the States, in inadequate attention given to core practice. Significant exceptions to this rule are, of course, found where steel and other castings are produced. These indicate to the intelligent observer the present availability of considerable equipment that can be economically employed, for preparing the core sand, for ramming the cores, for baking them, and for storage and transportation.

It may be truthfully said that while the industry as a whole has not paid adequate attention to core-making, the operation of ramming the sand in the core box has been developed with reasonable success in the average American steel foundry, simultaneously with considerable neglect in the selection of core mixtures and in the baking of the cores.

There is much yet to be done in determining the best materials to employ in making core mixtures for various classes of work. These include the sand used as a base and the green binder; and the permeability of the core, the relatively important skin of the core, and the many other considerations involved in baking the cores. There is considerable difference of opinion regarding desirable fuels for core ovens, temperatures to employ, periods of time for drying at designated temperatures, and circulation of heat in and insulation of core ovens. Some steel foundries have been carrying on extended investigations into this subject with resulting economies in progressive degree.

The average steel foundry in America uses a considerable quantity of silica sand as the base for most of its core mixtures. Some such foundries also employ sands not containing a high silica content, but characterised by a slight amount of cohesiveness, due to the presence of a natural clay substance. It is the practice in most plants to use a considerable portion of heap sand in core mixtures not bonded with oil. Sometimes the refuse from sandblasting is introduced into the core mixtures.

The use of oil as a binder for core sand is observed more in steel foundries making small castings, than where large ones are common. The author believes that in the steel casting industry such use of linseed or other oils is proportionately on the decline, due to a growing more careful discrimination in the use only of high-priced materials where the need exists; and to the reasonable success that has attended the manufacture of some classes of work where cheaper core binders than oil have been successfully substituted.

In the larger steel foundries there is much pulverised pitch used as a core binder, either in its pure form or as mixed with small percentages of other materials in what are called "core compounds." For many classes of work, large and small, pitch has indeed proved to be a highly satisfactory core binder, particularly advantageous in use with considerable percentages of heap sand. In that respect it differs widely from oil, whose function as a binder after drying does not satisfactorily come into play when the sand grain has a coating of clay which absorbs much of the oil without any appreciable benefit in temporarily making the sand grains cohere, as when such grains are clean.

The use of wheat-flour in American core sands has been of long duration. In recent years other farinaceous products have been employed to considerable extent as substitutes for it. The employment of any of these materials is often advantageous in reducing the amount of clay to give the required green bonding strength. It is becoming recognised more and more that a heavy proportion of clay in a dried core is disadvantageous in certain classes of work. Substituted bonding materials which go wholly or partly into combustion when the

metal is poured are being studied with reference to the volatile matter expelled in such combustion, and the effect this may have in causing porosity in the steel casting.

Cleaning Operations.

Equipment and methods employed in cleaning steel castings in American steel foundries are widely varied, according to the nature of the work produced. They represent a great deal of ingenuity that has been applied to this relatively expensive phase of steel casting manufacture. Since the 90's there has been a tremendous development in the installation of mechanical devices to take the place of hand chipping and other laborious operations that formerly produced high cost and unsightly appearance of the product as shipped.

In the larger foundries the pneumatic hammer is very extensively employed. Circular cold saws are frequently used for the removal of heads or risers on very large castings. In many open-hearth foundries, pneumatic chipping hammers, cold saws, grinding wheels, sand-blasting apparatus, hydraulic presses for straightening, and welding equipment constitute practically all of the cleaning facilities. Foundries specialising in the manufacture of small steel castings generally have gas-torch equipment for burning off gates and heads or risers, swing and stand (or stationary) grinding machines, apparatus for blasting with sand or a metallic substitute, pneumatic chipping hammers, tumbling barrels and welding equipment. Facilities for welding in the industry as a whole include apparatus for performing the operation electrically and by means of gas. Difference of opinion exists regarding the relative effectiveness of gas and arc welding. This is probably due to difference in the skill of operators. The author's experience has indicated the effectiveness of either method of welding in careful, experienced hands when proper equipment is used. Under those circumstances electric welding is the cheaper. Such welding in the States is done by means of metallic and carbon electrodes.

The sequence of cleaning and finishing operations in any foundry is appropriately given serious consideration, and should be decided largely by the nature of the work produced. These operations include the important one of heat-treating, to be mentioned later.

The extent to which thorough cleaning methods are applied to steel castings varies perhaps more than any other detail of such manufacture, except melting. Cleaning requirements, however, have a definite relationship to moulding and core practice, which are properly regulated to a large extent by the desired surface appearance of the product. Reference has been previously made to what is in the States a very marked differentiation in the surface finish. This factor has caused a great refinement of cleaning operations to be adopted in many steel foundries specialising in the manufacture of small castings.

Heat-Treatment.

The world war provided a great stimulus in the heat-treatment of steel castings made in the States, through the exacting physical tests for much ordnance work. Many foundrymen learned much of value regarding the effects of scientific heat-treatment. The depression in the industry which was marked in 1921, stimulated some steel foundrymen to improve their heat-treatment methods to even greater extent than was done during the war. There is now a very great interest in this subject in the industry and among users of steel castings. Researches are being conducted in many plants, and as a result many highly important facts are being established. Among those which have hitherto been misunderstood or practically disregarded, is the effect of the rate of cooling after heating in the annealing oven.

It may be appropriately explained here that engineering phraseology in the States now classifies under the term " heat-treatment " any method of heating and cooling, for the purpose of refining the structure. The word " annealing " is now used generally to define such heating when it is followed by a cooling operation in the oven. The term " normalising " is employed to mean such heating when it is followed by cooling in the air. The term " heat-treatment " as now used does not imply necessarily a secondary heating, and has a general, not a specific interpretation among American metallurgists.

Ovens used for heat-treatment in American foundries are called " annealing ovens." In most of these annealing ovens, pyrometers are installed. The fuel used for such ovens is selected according to the location of the plant and the availability of suitable coal, fuel oil, and gas (either natural or artificial). The annealing cycle varies tremendously according to the thickness of section. Probably the range is between 6 hrs. and 9 days. The period last named is employed for the complete operation in the case of cast steel rolls of diameters up to 48 in.

Physical and Chemical Requirements.

There has been a very interesting development during the last few years which has come to public notice within the last 12 months, regarding more exacting requirements for the physical properties of American-made steel castings. For a considerable period up to June, 1922, commercial specifications for the soft grade of carbon steel castings called for the following as minimum tensile-test values :—Ultimate strength per sq. in., 26.7 tons; yield point, 45 per cent. of the ultimate strength; elongation in 2 in., 20.00 per cent.; and reduction of area, 30.00 per cent.

Minimum values consistent with those enumerated above were prescribed for medium and hard steels.

Following a well-defined desire for more exacting specifications, expressed by consumers of high-grade steel castings for railway use, in which producers of such castings indicated a reasonable degree of acquiescence, a joint committee was formed to represent the American Society for Testing Materials and the American Railway Association. This committee conducted a very large number of tests following which it reported to the parent organisations. The result finally was the adoption in June, 1922, by the American Society for Testing Materials and by the American Railway Association, of tentative specifications for carbon steel castings for railway use which call for the following minimum tensile-test values for the " annealed " soft grade :—Ultimate strength per sq. in., not specified; yield point per sq. in., 13 tons; percentage of elongation in 2 in., 1,600,000 divided by the tensile strength; and percentage of reduction of area, 2,600,000 divided by the tensile strength.

The specifications stipulate that the elongation on 2 ins. shall not in any case be under 24 per cent.: and that the reduction of area shall in no case be under 35 per cent.

It is significant that minimum values for ultimate strength are not specified, and that the actual tensile strength must be determined, according to these tentative specifications, simply to ascertain by the formulæ the minimum figures for elongation and reduction of area. Values intended to be consistent with those for the " annealed " soft grade referred to in the foregoing were established for one harder grade. The term " annealed " was embodied in these specifications in place of the better one, " heat-treated." The tentative adoption of these specifications means their use on trial for one year from such adoption. It is, of course, optional with any consuming member of either association concerned in the formulation of these tentative specifications to purchase railway steel castings in accordance with these requirements. They will not have the inherent strength to influence the steel casting industry that will result, if, and when, satisfactory use of them as tentative has shown the desirability of making them permanent or standard. The elimination of minimum tensile strength values is the result of a growing disposition among railroad engineers who design steel castings, to regard the yield point as of paramount importance, compared with the ultimate strength, in establishing the proper factor of safety.

Tentative adoption of much more exacting requirements for physical properties in steel castings for railway use has naturally had its effect in causing producers and consumers of steel castings for other uses to scrutinise current specifications, with the idea of making them more in conformity with the better results in practice now being obtained, as compared with the results previously

secured when the industry was under less scientific control. At the annual meeting of the American Society for Testing Materials, to be held in June, 1923, revised specifications for steel castings for general use will be submitted to the Testing Society by its committee on steel, which has, through a sub-committee, given a great deal of study to this matter during the current year. It is premature to indicate with any exactness what the requirements will probably be after consideration by the entire personnel of the Testing Society. The author can safely offer his opinion that the requirements for the soft grade of carbon steel to be tentatively adopted will call for an increase in the percentage of elongation, and in that for reduction of area above the figures (22 and 30 per cent. respectively) now regulating the purchase of much cast steel for ordinary use; and that for such ordinary use it will not be considered advisable to eliminate the minimum value for ultimate strength in tensile testing. The probability is that a greater increase proportionately will be required in the value for reduction of area than will be demanded for the elongation.

It will be noted that the term "yield point" has been used throughout the references to standard and tentative specifications. The Joint Committee on Tests, representing the American Society for Testing Materials and the American Railway Association, was confronted by a desire on the part of certain railway engineers to make the "true elastic limit" the basis for revised specifications. After the most exhaustive precision and running tests, it was conceded that the present state of the art of testing provides no satisfactory instrument which, when properly used, gives consistent results to determine the "true elastic limit" of cast steel. Experimenters who have made many tests on steel castings and steel forgings have found a considerable difference in the behaviour of the two kinds of steel in this respect. Instruments are manufactured which indicate with satisfaction the phenomenon that follows strain beyond the "true elastic limit" of steel as forged. Considered from the standpoint of instruments that have been thus far developed, it may be said that steel as cast has no "true elastic limit," although it has a very well-defined "yield point," determined by the drop of the beam of the testing machine, or by the use of dividers.*

From preceding paragraphs it may be seen that physical requirements of an exacting nature are not only demanded by American industry, but are capable of being satisfactorily met in routine operations in American steel foundries. The large representation of steel founders in the organisations whose functions are to formulate specifications makes this point clear.

Specifications which have been in force for some years covering the manufacture of ordinary steel castings have sometimes called for bend-test requirements for soft castings. These provide for the bending cold of the specimen through 120 deg. around a pin 1 in. dia., without cracking on the outside of the bent portion. The specimen is machined to measure 1 in. × ½ in., with corners rounded to a radius not over 1/16 in. The tentative specifications for carbon steel castings for railroads do not call for a bend test. The general specifications to be submitted for revision to the Testing Society by its committee on steel will probably include an optional provision for a bend test, since such a test is strongly favoured by a few consumers, such as the United States Navy. Recently a great deal of study has been given to the subject of bend testing, and it is probable that, as a result, explicit instructions will be embodied in specifications at some future time regarding the manner in which a bend test shall be made. It has been determined that the manner of making the bend has much to do with the result of the test. Other conditions than those covering the section of the bend piece and the radii of the corners should be imposed.

Specifications for steel castings in use in the States have included certain requirements as to chemical analysis. The present standard specifications of the American Society for Testing Materials for steel castings call for the following:—

	Class A.	Class B.
Carbon	Not over 0.30%	
Phosphorus, Acid ...	„ „ 0.07%	Not over 0.06%
„ Basic ...	„ „ 0.06%	„ „ 0.05%
Sulphur		„ „ 0.06%

Class A castings as referred to above in the specifications mentioned need not be annealed unless so specified, and are intended for purposes justifying no physical requirements. Class B castings are those which are graded according to hard, medium or soft condition for which physical requirements are stipulated. The maximum limitation for phosphorus and sulphur mentioned above may be exceeded, according to the terms of the specifications referred to, by not more than 20 per cent.

The tentative specifications for carbon steel castings for railways adopted in June, 1922, call for a maximum limit in manganese content of 0.85 per cent. for either grade covered by the specifications, and a maximum limit for phosphorus as well as for sulphur of 0.05 per cent., without qualification. Most, if not all, of the steel foundrymen supplying railway and other castings, and some railway engineers, believe it is unscientific to establish such a maximum limit as has been imposed for manganese content. The author is in entire agreement with the objection, founded, as he believes it is, on reliable metallurgical data and comprehensive reports on many steels in service. It seems unlikely that any maximum limit for manganese will be proposed for the expected revision of current specifications for carbon steel castings for general use, at the convention of the American Society for Testing Materials, to be held in June, 1923, since an increasing and very large number of metallurgists and engineers associated with producers and consumers of steel castings feel that the manufacturer should be permitted to regulate the chemical composition of metal, when called upon to meet definite physical requirements. This opinion prevails with natural exceptions regarding the elements of phosphorus and sulphur, each of which occupies a different position in the influence exerted on physical properties. Since the specifications as adopted by the American Society for Testing Materials are the basis upon which practically all consumers' specifications in use in the States are formed, it is unnecessary to enumerate requirements in other specifications than those mentioned in the preceding. There is a very close co-operation between the American Foundrymen's Association and the American Society for Testing Materials which brings the organisation first named into conference, through designated representatives, in all committee activities of the Testing Society that relate in any important way to the foundry business. The friendliest feeling exists between these two important organisations, which have a combined membership of more than 4,500 men prominent in the manufacture or testing of engineering materials.

Instead of praising the quality of metal in steel castings produced in the United States, the author prefers to submit the facts mentioned above, indicating the requirements exacted by engineering practice for our industry. These requirements may be compared with those in other countries to the relative credit or discredit of the industry wherever located, on the fair assumption that average results obtained in daily practice necessarily exceed the minimum requirements called for, by reasonable margins.

Conclusion.

In the first part of this Paper the author took care to point out the very great extent to which the steel-casting industry in the States has become specialised. That fact can only be realised satisfactorily by visiting a large number of steel foundries in a wisely-selected, broad area of territory. Perhaps some appreciation of this condidition will be gained from the brief mention of many details of practice in previous pages. It is hoped that an erroneous impression may not prevail in some foreign countries regarding effects of what you term "mass production" and what we call "quantity production." The author, as a regular reader of British literature treating of the steel-casting industry, noticed with much interest some months ago a series of articles in

* "Proceedings of the American Society for Testing Materials," Vol. 22, Part 2, Page 2, Pages 150 to 171, "Tensile Properties of Steel Castings," by L. H. Fry.

one of your publications by an American friend, who endeavoured to explain for better understanding what is really the result on the product of quantity production in properly regulated foundries in the States. The exposition was made by one who is well informed regarding American foundry practice, and who, if one may judge from the nature of his occupation during several recent years, should be fairly familiar with foundry practice in the British Empire and on the Continent of Europe. His opportunities for making correct comparisons should outweigh his national prejudices. The opportunities the writer of this Paper has had for making similar comparisons have been quite limited, but have included examination of numerous foreign-made steel castings during the World War. Reasonable allowance for inferiority due to stress of war times is conceded. In the light of the limited knowledge of the author and the much greater knowledge of many of his acquaintances regarding the product made overseas, the writer feels justified in cautioning against an opinion that might be inadequately based, that the general average of steel castings made either in the United States or in Canada is of lower quality than that representing the product either of the British Isles or of the European Continent. The author's purpose in saying this is in no sense to start a controversy, which by the very nature of the case could not be easily settled, if at all, but to assist if possible, in the most satisfactory interchange of helpful views based on experience, and on sound hypothesis as to existing conditions at home and abroad. There is much that each of us can learn from the other when mutual respect for genuine accomplishment exists. We in America can profit by the study of your painstaking detail, resulting from a craftsmanship that has been long in the making. The Institution of British Foundrymen as a group can benefit by the scrutiny of American time-saving methods, employed both in quantity production and in the manufacture of short-order jobbing work. When both of us combine the best methods employed by each of us to the extent that local conditions permit, the English-speaking steel foundryman at home or abroad will have made much more progress than that of which he can boast to-day.

Perhaps every writer who attempts to discuss briefly a very large subject always approaches the end of his task with the uncomfortable feeling that his treatment of many details may be out of proportion with their actual significance. Whether or not this feeling generally exists, the author of this Paper confesses to the sensation mentioned. If his effort to enlighten his fellow-foundrymen abroad should stimulate them to the study of a more complete and far more satisfactory exposition of steel-foundry practice in the United States, he would recommend for careful examination a very instructive volume devoted to the subject written by a foundryman friend of the author.*

The writer wishes to assure his fellow-members of the Institution of British Foundrymen of the hearty co-operative spirit toward them of his closer associates in the American Foundrymen's Association. In the United States we watch with genuine interest and satisfaction its increasing growth. We cordially welcome your members to our foundries when on our shores. We congratulate you sincerely on being directed from time to time by those able past-presidents of your Institution whom we have been so fortunate as to have as guests. In the future we hope to know many of their successors and colleagues, and to aid and be aided by all of you in the most economical manufacture of the best steel castings that can be produced.

Societe Française des Acieries Basset.—This French concern, formed for the exploitation of the much-discussed Basset direct steel process, reports for 1922 a loss of over 517,000 fcs. (say £7,000). The accounts were submitted to the general meeting on June 30, at which a proposal was also discussed to revise certain contracts made with the Ougrée-Marihaye Company.

* "The Steel Foundry," 2nd edition (1922), by John Howe Hall.

A Novel Method of Scrap Sorting.

In many steelworks and scrap-breaking yards there exist large quantities of mixed alloy scrap, the value of which is extremely low due to the fact that, to procure usable material, either the lot must be melted and the chance taken as to whether the bath sample shows it to be an alloy capable of being made into commercial steel, or each piece of scrap must be separately analysed—usually a commercial impossibility. Similar conditions exist in the non-ferrous industries.

Messrs. Adam Hilger, Limited, of 75a, Camden Road, London, N.W.1, on the request of a large northern works, have developed a spectroscopic method of solving this problem. There is, however, one important proviso, viz., that the instrument must be selected and the technique defined by a spectroscopic expert. If this condition be fulfilled, it is possible for any intelligent young chemist or physicist not only to recognise the presence or absence of any metallic constituent, but to state roughly the percentage, as quickly as the pieces can be placed in position and removed by one or more labourers. In many cases, once the presence of one or two elements is established, the composition of the alloy can be guessed with a fair degree of accuracy, by those having knowledge of specifications likely to be associated with the material being handled.

As an example may be taken the sorting out of mixed steel (or control of rolling-mill production) where there may be accidental mixing of bars of carbon steel containing no more than a trace of nickel, with bars containing from 2 per cent. to 3 per cent. of that metal. To sort this rapidly and with certainty none of the spectroscopic equipments referred to in text-books are very suitable. Photography of the spectrum is by the nature of the problem excluded—for serious loss of time and lack of continuity in shifting would be occasioned by the necessity of developing and examining the photographs. If the percentage of the nickel is small, it will be found that there are very few of the nickel lines in the arc spectrum of a steel containing that metal which are continuously visible. On the other hand, the nickel double line at wave-length 5081, easily recognised by its position relative to the neighbouring iron lines and very distinctive in appearance, shines fairly steadily and with considerable intensity even when the nickel content is small.

This pair of lines is sufficient for the purpose in view. They require, however, for their efficient separation from the neighbouring iron lines a considerable resolving power, such as is afforded by a diffraction grating; while for general convenience of work the spectroscope should be of the well-known wave-length form.

Method Adopted.

One carbon steel bar is held in a suitable wooden frame, and the bars to be tested are then placed in position on the same frame one by one as rapidly as possible, connection with the electric mains being automatically provided through a suitable resistance. The arc is struck by touching both rods simultaneously with a third rod of iron or carbon steel insulated by slipping over one end a piece of ordinary rubber tube. Removal of this rod strikes the arc, and the observer at the spectroscope is able immediately to state whether the sample contains an important quantity of nickel or not. With the aid of three or four standard samples containing various percentages of nickel, the observer can soon accustom himself to state also the range of percentage within which the nickel content lies.

The detection of chromium and other metals is equally simple with the same instrument. The apparatus which our representative saw working was satisfactory, except that the arc required masking from the operator's eyes.

THOMAS ROBINSON & SON, LIMITED, engineers, of Fishwick Street, Rochdale, have removed their London office from 79, Queen Victoria Street, E.C.4, to Abbey House, 2, Victoria Street, Westminster, S.W.1.

BLADEN & COMPANY, LIMITED, Parkhead Girder Works, Bridgeton, Glasgow, are supplying the steelwork for the extensions to be carried out by the Forth and Clyde and Sunnyside Iron Companies, Limited, Falkirk.

Graphite in Grey Iron.*

By J. W. Bolton, Hamilton, Ohio.

The graphite of grey iron is one of the major factors governing quality. Therefore, study of the various phases of graphitisation should help foundrymen to produce better castings. The existence of graphite flakes is what makes grey iron a commercial possibility. If it were not for graphitisation, it would not be possible to produce a good machinable iron in the cupola. Graphite flakes help to give grey iron many of its unique engineering properties, such as rigidity and ready machinability. While graphite imparts desirable properties, it also gives some undesirable ones. Among these are little resistance to shock, low strength and open grain. Whether he realises it or not, the foundryman controls the quality of his castings largely by controlling the formation of graphite.

Since the question of graphitisation is such an important one, we need to know enough about it to exercise intelligent control. It is the writer's intention to outline as briefly as possible what we know to-day about the phenomena of graphite formation.

Graphite is found as weak, pencil-like flakes distributed throughout the metal. These flakes are largely graphitic carbon enmeshed in a ferrite (pure iron) network. They also contain some sulphides and occluded gases.

Besides graphite flakes, grey iron is made up of varying amounts of pearlite, ferrite and phosphide eutectic.

The graphite flakes are formed by the breaking down of the combined carbon of the iron during cooling. Some recent work shows that, under certain conditions, the original distribution of combined carbon has an important influence on the formation of graphite. That is, the first growth and distribution of graphite is determined by the form the combined carbon would have taken had the iron been chilled white.

Graphite influences the physical properties of the metal according to its amount, its size, its distribution, and its shape. The bulk of graphitisation takes place between the final solidification (eutectic) and the formation of pearlite (the eutectoid). This graphitisation ordinarily affects only the free combined carbon which is called cementite, and is found as such in irons with over 0.90 per cent. combined carbon. Unfortunately, graphitisation does not always cease here but takes up carbon from the pearlite. This reaction is accompanied by the phenomenon of graphite growth, as distinguished from primary graphitisation. The result is large, coarse flakes of graphite surrounded by weak envelopes of ferrite. This condition causes low strength, brittleness, and open grain. As the writer has pointed out in other papers, it is probable that graphitisation of commercial irons proceeds below the pearlite transformation range, ceasing only when the rigidity of the metal prevents further migration of carbon.

Controlling Growth of Graphite Flakes.

The growth, or size of graphite is influenced by the rate of cooling, the variation in size of the first flakes, and the condition of the metal layers between flakes. Under present conditions, the rate of cooling is governed largely by section size. Where castings are fairly small and have reasonably uniform sections, the effects of cooling can be balanced very nicely by regulating the silicon. However, in the heavy machine tool work, with the general run of castings from 5 to 25,000 lbs., and sections from one-quarter to 8 in. deep, the very closest supervision is necessary. That the author has established an average of 4,150 lbs. (A. S. T. M. bar) for one of his mixtures (over a long period) and can produce a reasonably close grain iron in heavy sections is evidence of practical accomplishment.

General laws of crystal growth show that growth is accelerated by having crystals of varying size, so that the large grow at the expense of the small. The practical significance of this is that if there are coarse flakes arising from some pre-existing component, say prima austenite, and small flakes from another, say ledeburite, there is more likely to be growth than if the whole structure is fine, say of eutectic composition. This explains why, under certain conditions a higher total carbon may produce a stronger iron. If the iron is of eutectic composition, for example with 3.75 carbon, the initial graphite will be in small flakes, and growth may be hindered at first. On the other hand, the presence of more graphite (its mass acting as an accelerator for growth) and the effect of a greater volume of graphite (if growth is at all complete) may have the opposite effect. The fact is that to-day foundrymen cannot specify a single maximum carbon for all grades of castings. All the factors must be carefully weighed. In some places, in very heavy sections low carbon may be best. In small sections it is likely that rather high carbon will give the desired results. If, beside the actual flake structure of the graphite, the variations in melting practice necessary to produce different carbons are considered, and the possible effects of these changes, it is seen that the carbon question is indeed a complex one.

Effect of Silicon.

Silicon is the element by which the foundryman manipulates his carbons, controlling the ratio of combined to graphitic. The exact mechanism of silicon action is not completely worked out. It behaves much like carbon in the iron crystal, suggesting possible interchangeability. It lowers the amount of carbon required for the eutectic so that for small castings higher silicon and lower carbon should give better results than higher carbon and lower silicon.

Foundrymen Favour Low Carbon for Strong Irons.

In order to make this Paper more interesting to the practical foundryman, questionnaires were sent to a number of leading American foundrymen and metallurgists. The questions were designed primarily to find out just how the industry thinks about the carbon-graphite question. The answers show that 95 per cent. of the men questioned favour low total carbon for high strength associated with high deflection irons. To get an iron 4,000 lbs. transverse test on the A. S. T. M. bar, silicons ranging from 1.10 to 2.35 per cent. were advocated. This is considerable range, especially when the majority recommended 3.00 to 3.25 per cent. carbon to accompany this silicon content. The majority advocated phosphorus about 0.40 per cent., ranging from 0.30 to 0.60 per cent. Sulphur up to 0.10 was specified. The general opinion was that the manganese should be 0.50 to 0.80 per cent.

The fourth question asked what should be the proper factor for converting transverse to tensile strength. Answers varied from 6.70 to 9.30, a difference of over 25 per cent. It was brought out that quite a number of foundries do not use the A. S. T. M. bar. The writer thinks, as a result of conducting a number of tests on various size and shape bars that it is not accurate to convert tests using the section moduli. We have to use the same bar to get comparison, and the bar must be 1.25 in., not 1.40 or 1.10 in. (*i.e.*, caliper the bars). We could take a square bar, get a high deflection and strength, then calculate it to a round, with considerable advantage to the results. But no one would be fooled except ourselves. Also, the apparatus for measuring deflection should be specified. We want the bend of the bar itself, not the relative movement between the centre knife edge and the table. The testing societies should specify how this test should be made.

The majority of those who answered felt that 15 per cent. to 20 per cent. steel gives the best results. None expressed any decided preference for machine or sand cast pig. A number recognised causes of open-grain other than high graphite. In this connection it should be mentioned that an open-grain iron with a ground finish will present a better appearance than a close-grain iron finished on a lathe or planer. The microscope furnishes the only means (beside fracture) of distinguishing the real grain structure in all cases.

* Abstract of a Paper presented to the Cleveland Convention the A.F.A.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Although continuing exceptionally quiet, the Cleveland iron market gives evidence of a slight increase of activity in buying, mostly, it must be admitted, on home consumptive account, while the volume of inquiries to hand foreshadows some improvement in actual business which in all probability may materalise as the current quarter advances. The main factor in the position is, of course, the question of fuel costs, which must ultimately determine the selling prices of pig-iron, but while the tendency of coke quotations is to slightly lower levels, the current rates altogether preclude any substantial reduction which would induce buying on a greatly enlarged scale. The disturbed political situation of Continental industries has also had a corresponding effect upon Tees-side export trade, as evidenced in the shipment returns from the Port of Middlesbrough, which, during June, amounted to only 26,019 tons (including Skinningrove, 1,507 tons), as compared with 32,467 tons in May, a decrease of 6,448 tons. As compared with the April total, the decrease is no less than 28,416 tons. With regard to current prices, No. 3 G.M.B. is now quoted down to 110s. per ton, with No. 4 foundry at about 102s. 6d. to 105s., and No. 4 forge 100s. The last-named could, perhaps, be done at as low as 100s. for a substantial order. There is only very little No. 1 obtainable, but the demand for this quality is negligible, and the quotation is anywhere between 115s. and 120s. per ton.

The inquiry for hematite is, perhaps, a trifle better, but outputs are far in excess of effective demand, and the necessity of closing down furnaces unless business improves is freely discussed. Prices have weakened steadily, but makers are in an extremely difficult position while the price of coke remains so high. This week they were quoting East Coast mixed numbers at about 109s. to 109s. 6d. per ton, and they would probably shade even this quotation for any substantial orders. No. 1 is at a premium of 6d. per ton. Prices of West Coast hematite are sagging, and Bessemer mixed numberg, which stand nominally at 118s. 6d. per ton, delivered at Glasgow and Sheffield, and at the same figure for export, are being shaded to secure orders. There is, however, very little business available. The Continent is buying very sparingly, and then only to satisfy any urgent needs that they may have, while home users have very slender requirements. The demand for low-phosphorus iron by Midland users has fallen off, but there is a fair inquiry for charcoal iron.

MANCHESTER.—Lancashire consumers of foundry pig are still determinedly holding off the market, the very small amount of actual business passing applying only to retail quantities just sufficient to meet urgent requirements from day to day. Buyers in the local market are doubtless influenced to a great extent by the recent downward tendency of pig-iron prices all round, Cleveland qualities having depreciated by upwards of 15s. per ton, while Derbyshire makers have only reduced quotations by half that amount. Even the more moderate amongst the Lancashire buyers of pig-iron consider that another 10s. ought to come off the price of foundry; that is to say, that the price ought not to be more than 97s. 6d. delivered in Manchester, and the others claim that the price should now be what it was before the French went into the Ruhr district. Furnace owners, however, threaten to blow out the furnaces before they will sell at that price.

THE MIDLANDS.—To a certain extent, conditions in the pig-iron industry in this area disclose a more favourable position than might have been expected, a fair volume of export business being reported, and this, of course, relieves the pressure on the local market. Were it not for this, probably prices would be weaker than they are. As it is, they are very indefinite. Some selling agents frankly admit that the prices they are quoting are largely nominal, that they do not refuse any reasonable counter offer which may be made to them, but submit it to headquarters. Mostly these counter offers are accepted. There is a rather better trade in foundry iron, but even this is not what it should be under normal conditions. Quotations approximately rule:—Northamptonshire No. 3 foundry, 100s. to 102s. 6d.; Derbyshire No. 3 foundry, 102s. 6d., all net f.o.t. furnaces.

SCOTLAND.—With the imminent approach of the annual summer holidays, business in Scottish pig-iron is on a more than usually restricted scale, and until some revival of the foundry industry can be realised the prospect of a substantial recovery must be regarded as remote. However, consumers have evidently run their stocks down to the point at which replenishing is necessary, as there is an improvement in the demand from the light-castings people, and although the tonnage involved is not substantial, it is nevertheless very welcome. No. 3 Middlesbrough has been done at £5 15s., and No. 4 foundry at £5 10s. f.o.t. Grahamston, whilst No. 3 Midland iron is on offer at £5 10s., and No. 3 Continental at £5 7s. 6d. Prices of Scotch iron are now easier again, and No. 3 is quoted at £5 10s. f.o.t. furnaces.

Finished Iron.

The outlook in the market for finished material has undergone little change since last reported, and though the quarterly meeting at Birmingham this week may disclose some movements of importance in a general sense, it is not considered probable that there will be any outstanding events as regards price alterations, or an improvement in the buying capacity of consumers. Reports as to marked bars are still fairly satisfactory, the mills being well employed on contracts, but new demand has been quieter as the end of the quarter approaches, and the market is indulging in speculations as to whether the standard price will be reduced this week. Demand at present is spasmodic and poor, and there is great pressure for reductions. Some of the best known makers of crown bars still adhere to £12 10s., and assert that there is no profit in them at a lower price, but against this has to be set the undoubted fact that other brands are quoted at £12, and even less. In the same way some makers of nut and bolt bars still quote £11, but others will accept less, and are still well above the Belgian price.

Steel.

Many of the principal firms in the steel industry having been, as usual at the close of the half-year, occupied in stock-taking, business in the various markets has been curtailed, while new contracts for the moment are negligible in volume. In the alloys market ferro-manganese constitutes the bulk of the inquiries, both in large and small quantities, and the general conditions of the market are fully maintained. Prices are firm, some of the makers being booked some months ahead, while Continental inquiries continue to come in fairly freely. In the Sheffield steel market Continental competition is making itself felt again, billets being offered at £7 7s. 6d. and blooms and slabs at £7 to £7 2s. 6d. Buyers, however, do not seem to be attracted to any extent. Local quotations for basic acid billets are unchanged. The demand for the latter is now so restricted that less than half the furnaces are operating. The tinplate market continues dull and uneventful, with only a moderate inquiry, buying being restricted mostly to actual requirements, which are now of limited volume. Current prices for the standard sizes may be quoted as follow:—Coke tinplates: IC, 14 by 20, 112 sheets, 108 lbs., 23s. 1½d. to 23s. 3d. per box; IC, 28 by 20, 56 sheets, 108 lbs., 23s. 7½d. to 23s. 9d. per box, with usual options, as per schedule, net cash, f.o.b., Bristol Channel ports.

Scrap.

In all the principal consuming centres for scrap metals, the demand has been reduced to a minimum average, and the limited business passing presents few outstanding features of interest. In Lancashire the stagnation in the foundry trade has, of course, an adverse effect upon demand for some qualities of scrap, but old cast-iron railway chairs seem to have been selling lately at rather more than the price for broken machinery metal, which is unusual; there are, however, some users of cast-iron who have a special liking for railway chairs. The quotations for good foundry scrap, such as broken machinery castings, range from 80s. to 85s. per ton, or roughly at 20s. to 25s. per ton below the prices for foundry pig-iron. The consumption at such a difference would, in ordinary times, be large; but, at present, ironfounders have little work in hand, and so they are not using much scrap. In Scotland, for reasons advanced above, the market is practically dead for all qualities of cast scrap. Heavy machinery metal and scrap chairs are difficult to dispose of, and it is doubtful if more than 90s. to 92s. 6d. could be obtained. Ordinary heavy cast-iron scrap runs about 85s. Light metal is at 75s. and furnace firebars at 70s.

Metals.

Copper.—The general tendency of value of standard copper during the past week has been consistently steady, quotations recording but few except trifling fluctuations, inclining, however, to slightly lower levels. There is little change to report in the general situation. Warrant prices again receded under a renewal of heavy speculative selling on home and Continental account. The position remains unsettled, there being no very hopeful feeling as to the possibility of any important recovery in the near future. Current quotations :—*Cash* : Thursday, £65 ; Friday, £64 15s. ; Monday, £65 ; Tuesday, £65 5s. ; Wednesday, £65 15s. *Three Months* : Thursday, £65 12s. 6d. ; Friday, £65 7s. 6d. ; Monday, £65 12s. 6d. ; Tuesday, £65 17s. 6d. ; Wednesday, £66 7s. 6d.

Tin.—The continuous decrease in home consumption and Continental demand has had an unsettling effect upon the standard tin market, and prices of late have recorded a substantial decline. America has taken very little interest in the London market, in spite of the fact that her reserve stocks are understood to be getting rather low. The disturbed state of the market has obviously discouraged America from making provision for her needs over the third quarter, and the trade demand in other directions has remained restricted.

MESSRS. RICARD & FREIWALD'S statistics of tin for June are appended :—

STOCKS, LANDING AND AFLOAT, EUROPE AND AMERICA : United Kingdom : Stocks in London, 2,031 tons ; stocks in other ports, 2,535 tons ; total, 4,566 tons ; landing and in transit, 35 tons ; afloat from Straits, 275 tons ; afloat from Australia, 70 tons. Total United Kingdom, 4,946 tons. Holland : Banca spot, 2,297 tons ; Banca and/or Billiton afloat to Europe and America, 757 tons. Continent : Straits afloat, 1,280 tons. United States : Spot and landing, 2,137 tons ; afloat, 6,345 tons. Total visible supply, 17,762 tons. Current quotations :—*Cash* : Thursday, £177 5s. ; Friday, £177 12s. 6d. ; Monday, £181 7s. 6d. ; Tuesday, £180 7s. 6d. ; Wednesday, £181 2s. 6d. *Three Months* : Thursday, £178 12s. 6d. ; Friday, £179 ; Monday, £182 12s. 6d. ; Tuesday, £181 12s. 6d. ; Wednesday, £182 2s. 6d.

Spelter.—Following the advance in values in last week's market there has been a lower tendency in quotations for this metal, which, however, has attracted some buying on the strength of a better home demand. Reports from America indicate a slightly firmer tendency there, with the possibility of some restriction in output in consequence of the low price. Current quotations :—*Ordinary* : Thursday, £27 17s. 6d. ; Friday, £28 ; Monday, £28 5s. ; Tuesday, £28 12s. 6d. ; Wednesday, £28 12s. 6d.

Lead.—The market for soft foreign pig continues quiet, with the tendency of values a shade easier. Demand remains fairly active, but metal has been more freely offered, and consequently values have receded to a partial extent. Current quotations :—*Soft foreign (prompt)* : Thursday, £23 17s. 6d. ; Friday, £23 15s. ; Monday, £24 2s. 6d. ; Tuesday, £24 7s. 6d. ; Wednesday, £24 7s. 6d.

Personal.

MR. G. G. COPPEL has been elected chairman of J. J. Saville & Company, Limited, in place of the late Sir A. J. Hobson.

SIR EDWARD MANVILLE, M.P., has been elected chairman of William Jessop & Sons, Limited, in succession to the late Sir A. J. Hobson. He is deputy-chairman of the Birmingham Small Arms Company, Limited, and a vice-president of the council of the Federation of British Industries.

MR. A. W. KILPATRICK, has been taken into partnership by Clarkson, Hood & Company, engineers' agents, of Atlantic Chambers, 45, Hope Street, Glasgow. The firm are Scottish representatives for A.C.E.C. (Ateliers de Constructions Electriques de Charleroi), Watshams, E. G. Lind & Company, Limited, and Townshends, Limited.

Wills.

BORNEMANN, J. A. D., a director of Ruston & Hornsby, Limited, engineers, of Lincoln £61,494

HEATON, A., of The Grange, Liversedge, Yorks., founder of Arthur Heaton & Company, engineers £19,774

COLONEL H. A. JOHNSON, chairman of Richard Johnson & Nephew, Limited, died suddenly on July 6 at Allestree Hall, Derby.

METALS (BIRMINGHAM), LIMITED, are being wound up voluntarily, with Mr. C. T. Appleby, Corporation Street, Birmingham, as liquidator.

Gazette.

MESSRS. C. F. CHAPPLE and T. E. Vaughan, iron and wire goods manufacturers, 166, Kingsland Road, E., trading under the style of C. F. Chapple & Company, have dissolved partnership.

MESSRS. A. E. HALL and A. P. Laughland, general engineering agents, Exchange Buildings, Stephenson Place, Birmingham, trading under the style of Egerton Hall & Company, have dissolved partnership.

MESSRS. C. H. LAXTON and G. Wicks, engineers' stores suppliers, 146a, Queen Victoria Street, London, and 21, Southwold Road, Clapton, E.5, trading under the style of C. H. Laxton & Company, have dissolved partnership.

THE PARTNERSHIP heretofore subsisting between Messrs. W. Houghton, J. E. Riley and A. H. Spring, engineers and stampers, Hurst Green, Cakemore, Blackheath, near Birmingham, under the style of The Premier Stamping & Engineering Company, has been dissolved, so far as concerns Mr. J. E. Riley.

IN THE Chancery Division, counsel for Lloyds Bank, moved for the appointment of a manager and receiver of the Widdop Engine Company, Limited, Halifax. Plaintiffs held a debenture for over £24,000, covering the whole of the assets, and they had made a demand, calling in the money. A petition for winding up was pending. Mr. Norton, chartered accountant, of Halifax, was suggested to act as receiver and manager. Counsel for defendant company consented to the appointment, and it was approved by the Court.

AT THE MIDDLESBROUGH BANKRUPTCY COURT, recently, W. A. Patterson, of Hillcrest, Lealholme, carrying on business as J. Horsley & Company, at 23, North Street, Middlesbrough, as engineers' merchants, appeared for his public examination. His liabilities amounted to £3,947, of which £3,252 were expected to rank, and his assets to £1,407, leaving a deficiency of £1,844. Debtor attributed his failure to loss arising from carrying on business owing to falling markets and paying too high a price for goodwill. The hearing was adjourned until July 13.

Company News.

Steel Developments, Limited.—Interim dividend, 5 per cent. per annum, free of tax.

Mond Nickel Company, Limited.—Final dividend, 7½ per cent., free of tax, making 10 per cent. on ordinary.

C. A. Paul & Company, Limited, 36-8, Ealing Road, Brentford, Middlesex.—Capital £3,500 in £1 shares. Engineers.

Gibbons (Dudley), Limited.—Interim dividends on preference and ordinary shares, 7 per cent. per annum, free of tax.

Millom & Askam Hematite Iron Company, Limited.—Owing to delay in settlement of question of excess profits duty, not yet possible to complete accounts for year ended September last.

P. G. Allday & Company, Limited, 117, Northwood Street, Birmingham.—Capital £15,000 in £1 shares (3,000 7½ per cent. cumulative preference). Brass manufacturers. Director: P. G. Allday.

Agricultural & General Engineers, Limited.—Approximate loss, £150,000; dividends on first and second cumulative preference shares passed; proposal for re-organisation of capital to be issued.

D. Wiseman & Bros., Limited, 260A, Coventry Road, Small Heath, Birmingham.—Capital £12,000 in £1 shares. Engineers, etc. Directors: H. L. Wiseman, W. E. Wiseman, D. F. Wiseman and P. J. Jammett (managing director and chairman).

Dobson & Barlow, Limited, Kay Street Machine Works, Kay Street, Bolton.—Capital £500,000 in £1 shares, to acquire the business of Dobson & Barlow, Limited. Engineers. Directors: J. L. Rushton, B. P. Dobson, H. L. Rushton and H. W. Woodman. Secretary: P. de Rouse.

Institute of Metals.—The annual autumn meeting of the Institute of Metals will be held this year in Manchester on September 10-13, and will open with the second annual autumn lecture to be delivered by Lt.-Col. Sir Henry Fowler, K.B.E., on "The Use of Non-Ferrous Metals in Engineering." The mornings of September 11 and 12 will be devoted to the reading and discussion of papers. After an official luncheon on September 11, visits will be paid to several large works in the vicinity of Manchester, and in the evening there will be a Reception at the University, when the new Metallurgical Laboratories will be officially opened.

XUM

Trade Talk.

A. W. MEAD & COMPANY, metal merchants, etc., have removed from 110 to 115-117, Cannon Street, London, E.C.4.

OWEN & DYSON, LIMITED, ironfounders, etc., of Rotherham, have removed their London office from 15, Victoria Street, to St. Stephen's House, Victoria Embankment, S.W.1.

LICENCES under the non-ferrous metal industry Act have been granted to Mr. H. C. Jones, 81, King Street, Bury; and Mr. C. H. Walters, 28, Radnor Road, Handsworth, Birmingham.

R. & J. SMITH BROTHERS, LIMITED, iron, steel and metal merchants, of Bridge Street, Sheffield, have been appointed agents in Yorkshire for the Delta Metal Company, Limited, and for Heaton & Dugard, Limited, Birmingham.

INTERNATIONAL ENGINEERING CONGRESS.—The American Society for Testing Materials is considering an international engineering congress to be held in Philadelphia in 1926 in connection with an exhibition to be held there that year.

DAVISON & WEBSTER, of 22, Waldon Street, West Hartlepool, have been appointed sole representatives in Northumberland, Durham and North Yorkshire of the Chemical and Technical Engineering Company for the sale of their products Corebind, Pullo, etc.

THE MACHINERY for the wire mills, etc., at the works of the Indian Steel Wire Products, Limited, has been erected ready to work; nail machines have also been installed and are giving satisfaction. The factory buildings and staff quarters are practically complete, and a suitable railway siding has been constructed which provides facilities for the haulage of the raw materials and finished products. The mills started producing during December last.

THE CARILLON of twenty-two bells erected at Bournville in 1906—the first carillon with clavier cast and erected by an English founder in Great Britain—is now to be completed with fifteen new bells, giving a total compass of three octaves. The bells are the gift of Mr. George Cadbury, junior, to the village in memory of his father. The carillon and clavier are being reconstructed and the new bells cast by the orignal founders, Taylor & Company, Loughborough, who hope to complete the work by the end of August.

UNITED STEEL COMPANIES, LIMITED, have removed their London office from 15, Victoria Street, to St. Stephen's House, Victoria Embankment, S.W.1. The London address of the following subsidiary companies has therefore also been changed: Steel, Peech & Tozer, Limited; Frodingham Iron & Steel Company, Limited; Workington Iron & Steel Branch of the United Steel Companies, Limited; Distington Hematite Iron Company, Limited; Samuel Fox & Company, Limited; Martino Steel & Metal Company, Limited; Daniel Doncaster & Sons, Limited; and United Strip & Bar Mills, Limited.

ED. BENNIS & COMPANY, LIMITED, have just received the order for the ash removal and dust extraction plant for the new generating station at Morwell, Australia. The order comprises a complete pneumatic suction ash and dust extraction plant, including auxiliary and accessory equipments in two duplicate units, each unit being for the purpose of removing the ashes, soot and flue dust from a range of six water-tube boilers and chimneys, with three chain grates per boiler, being 18 chain grates for each unit, or 36 grates for the complete plant. The plants are to be interconnected, so that either plant will serve either range of boilers. Each plant is to be capable of removing the ashes from the boiler house to the storage bunkers, at the rate of six tons per hour. The contract includes two ash receivers, each 2,400 cubic ft. capacity.

SMEETON-WRIGHT FURNACES, LIMITED, who have recently removed to larger offices at St. Stephen's House, Victoria Embankment, London, S.W.1, inform us that owing to their business having grown considerably they have found it necessary to increase their financial resources with a view to further development. They inform us that Mr. E. S. H. Corbett and Mr. S. H. Morden, of J. Whittall & Company, Limited, late of 9, Fenchurch Avenue, E.C., now of St. Stephen's House, have accepted seats on their board, Mr. E. S. H. Corbett having been elected chairman of directors. Smeeton-Wright Furnaces, Limited, continue to carry on their business as specialists in the design and construction of furnaces. Arrangements have been made to deal also with equipment and machinery for use in iron and steel works and the design of complete lay-outs.

Obituary.

MR. J. M'NAB, who has had 72 years' service in the shipbuilding industry, has died in his 89th year at Dumbarton.

MR. ROGER BECK, of the Mumbles, Swansea, died on Thursday of last week. He was originally associated with Wright, Brother & Company, and became a director of Baldwins, Limited, when they amalgamated with Wright, Butler & Company. He was 83 years of age.

MR. J. G. BARFORD, governing director of the agricultural engineering firm of Barford & Perkins, Limited, Peterborough, died on June 30. Mr. Barford, who was 62 years of age, was the son of the late Mr. William Barford, an original member of the Peterborough Town Council.

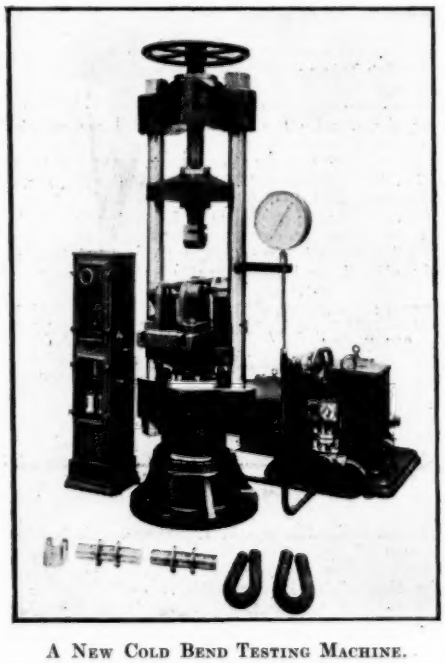
MR. ARTHUR WADHAM, founder and chief proprietor of our esteemed contemporary, "The Machinery Market," died on July 3 following an operation in a nursing home at Carlisle. When the business was turned into a limited liability concern, under the style of the "Machinery Market," Limited, Mr. Wadham became managing director.

Cold Bend Test Upon Iron and Steel Bars.

A convenient and useful form of testing machine has just been completed by Messrs. W. and T. Avery, Limited, Birmingham, for carrying out cold bend tests upon iron and steel bar specimens, in accordance with the British Engineering Standards Association specification.

The test is well known amongst manufacturers, and usually consists of bending the bar, when cold, through an angle of 90 deg. round a mandril having a radius equal to the diameter or thickness of the bar. The two ends of the bar are then closed together in the machine, after which the bar must exhibit no signs of fracture.

As will be seen from the illustration, the machine



A NEW COLD BEND TESTING MACHINE.

is of the hydraulic type, being supplied with pressure from a motor-driven pump. The hydraulic ram is raised by the pressure, carrying with it the bar specimen, which is spanned across the two upturned presser feet fitted with rollers.

A middle presser-foot is attached to a central adjusting screw, and the bar specimen is brought to bear against the former by the action of the ram, thus bending it through a right angle. The bent bar is then removed and placed again in the machine, to complete the test by bringing the two ends together, making a total bend of 180 deg.

The load necessary to carry out the test is shown upon a pressure gauge. The machine itself is capable of applying a pressure of 60 tons to the specimen.